FOUNDRY TRADE JOURNAL

Established 1902

Vol. 96 Thursday, January 28, 1954 No. 1952

PRINCIPAL CONTENTS

	PAGE
Features	
Leader: Factors for Progress	89
New Equipment	90
Notes from the Branches	98
New Catalogues	102
Publications Received	108
Forthcoming Events (Advert. section)	33
Technical	
Heat-treatment of S-g. Cast Irons, by Marcel Ballay, Raymond Chavy and Jacques Grilliat	91
Foundry "Brain's Trust"	99
Rational Foundry Management, by F. Buckley	103
Impregnation of Metal Castings	107
News	
I.B.F. Awards	90
I.V.E. Section Dinner	90
Moulding-pit Accident	102
J. Hobkirk's Board Changes	106
Closing of Newmain Foundry	109
Colombo Plan Advisers Appointed	109
Obituary	109
Personal	110
News in Brief	111
Raw Material Markets	114
Statistics	
Current Prices of Iron, Steel and Non-ferrous Metals (Advert. section)	32

PUBLISHED WEEKLY: Single Copy, 9d. By Post 11d. Annual Subscription, Home 40s. Abroad 45s. (Prepaid).

49 Wellington Street, London, W.C.2. 'Phone: Temple Bar 3951 (Private Branch Exchange) Grams: "Zacatecas, Rand, London"

Factors for Progress

When visiting medium-size foundries we are constantly being asked as to whether mechanization is to be advocated. We usually feel like asking for a definition of what is meant by this word. If the answer be the installation of a maze of conveyors, our answer would be "not yet." All foundries possess some mechanical aids to production and none is devoid of such plant, whilst those employing a few hundred people possess much. They probably have a good melting plant, a battery of moulding machines, a modern sand-preparing plant, serviceable cranes, and a central laboratory. For such a concern what is obviously lacking is a few lengths of conveyor, trucks and stillages. By taking such steps, moulds, castings and process scrap can be kept from occupying valuable floor space for prolonged periods. This type of foundry is, or should be, in a position to know the monetary gain arising from each step taken towards mechanization and this will be a help when envisaging further developments. The strength of these medium-size foundries often lies in the variety of work undertaken, and variety involves elasticity in manufacturing operations. In all development work this must be kept well to the forefront until the time arrives when complete specialization may become economic.

For the smallest foundries, even these labour aiding devices are prohibitive on account of cost, but here a start should be made with control instruments capable of being used by the man on the shop floor. We remember—many years ago—being invited to the opening of a small jobbing foundry and insisting that a weighing machine must be installed if the firm was to make progress. To-day it is quite a large business—with meticulous attention being paid to every phase of control. Yet we were recently disgusted to learn that a serious percentage of cupolas are still being run without the aid of a weighing machine. A second piece of inexpensive control apparatus, and again one capable of operation by a man on the floor, is a moisture indicator. If benefit be found from these two simple pieces of plant, then the system should be extended to collect information as to mould hardness. Moreover, the ordinary watch—not a stop-watch—can be used to find out which are the most time-absorbing or even -wasting duties, and then thought can be given to their reduction. One result of such an examination will reveal—in most cases—the unreadiness of the shop to start moulding first thing in the morning. It may happen that starting a small—a very small—night shift will reduce production costs.

In the largest shops, where heavy production is carried out using the piecework system, then it is useful to make a calculation of the loss of earnings as related to the cost of a break for a cup of tea. It will usually show that the operative is paying more than luxury hotel prices for this refreshment. Such large concerns as have been committed to the principle of mechanization, must be continuously on the alert to keep the machinery working without a stop; to eliminate bottlenecks; to reduce fatigue amongst the operatives; to ascertain where variables exist, and take steps to keep them to a minimum. Thus for the three types of foundry indicated there are quite different approaches towards progress.

I.B.F. Awards

A number of awards by the Institute of British Foundrymen, which are based on the results of the City & Guilds examinations in foundry practice and pattern-making, have been announced.

P. H. Wilson prizes, which are given to successful candidates in the "intermediate" grades, were awarded as follow:—

In patternmaking, Frank Allinson, of the Constantine Technical College, Middlesbrough, receives the first prize, and Brian Chidgey, of Rochdale, Municipal Technical College, and Guy Chatterton, of Leeds, were given second prizes.

In foundry practice, Phillip Jeffrey, of Lincoln Technical College, receives the first prize and Michael William Grundy, of the County Technical College, Wednesbury, was awarded second prize.

Buchanan Prizes, which are given on the result of the "final" examinations, were awarded as follow:—

In foundry practice, the Buchanan Silver Medal was awarded to Paul Robertshaw, of Halifax, and Buchanan book prizes were awarded to Abdul Majid Sheikh, of Battersea Polytechnic, and Kenneth Womble, of Wolverhampton. In patternmaking, Buchanan Prizes were awarded to Robert Dobbie Reid, of Dundee, and Norman Frederick Chapman, of Leicester.

I.V.E. Midland Section Dinner

A very successful stag party of the Midland Section of the Institute of Vitreous Enamellers was held last Friday at the White Horse Restaurant, Birmingham. Over 80 members and guests were present (a figure which might have been augmented had not the function clashed with the annual dinner/dance of the local branch of the Institute of British Foundrymen). Mr. A. W. Murdoch, the section chairman, presided. After dinner, Mr. J. Fallon, J.P., M.I.Mech.E., proposed the toast of "The Institute" and Mr. Biddulph, chairman of the Institute responded. To "The Visitors" proposed by Mr. Murdoch, Mr. E. R. Evans replied. This concluded the formal part of the programme, the rest of the evening being convivially spent with the aid of Mr. Bastick at the piano. The arrangements were admirably carried through by Mr. D. Sleath, section secretary.

"Life in Industry"

This title covers 66 paintings by contemporary artists, currently being exhibited at Management House, 8, Hill Street, London, W.1. One of the outstanding omissions from the display is that of any picture of a foundry. Among a variety of industries represented—railways, mining, shipbuilding, steel-making—this absence may seem a little strange, for surely founding can be no less a source of inspiration than some of the industries well covered. Many of the paintings are strikingly effective, illustrating in a great range of media—oil, watercolour, gouache, crayon and pen—the many aspects of industrial life to-day, either as general views or detailed studies of technical processes. Admission to the exhibition, which is the first of its kind to be held in London, is free, and the show remains open until February 14.

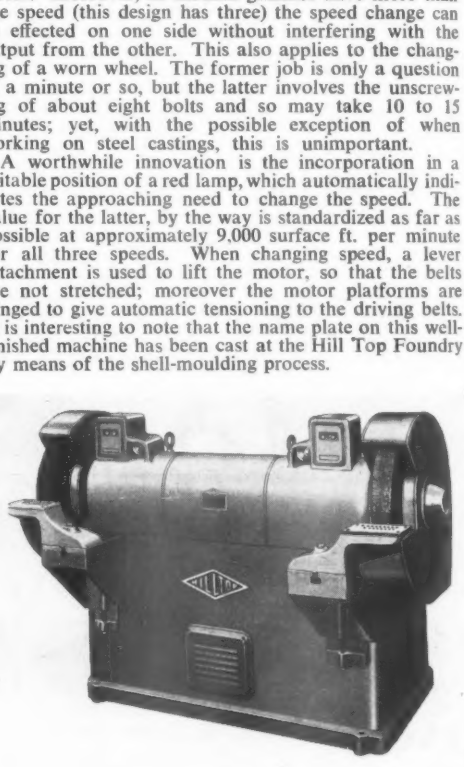
New Equipment

Fettling-shop Grinder

Our representative recently, during a visit to the Hill Top Foundry, Wednesbury, had an opportunity of inspecting a new design of double-ended grinder which is sold through the Molyneux Foundry Equipment Company Limited of Marlborough Road, London, N. 19. It is available in two sizes, the larger taking 30-in. dia. wheels and the smaller 24-in. In both cases the distance between the wheel centres is 61 in., which allows ample elbow-room for the operators. Naturally, with a new design (the model is illustrated below) proper attention has been given to dust extraction, and the system incorporated is that developed jointly by the British Steel Castings Research Association and the Foundry Trades Equipment and Supplies Association.

Because the wear on the two wheels in use may be unequal—owing, say, to one man being absent for a shift or the use of two different grades of abrasives—each one is independently driven by a 7½ or 5½ h.p. motor. Moreover, as modern grinders have more than one speed (this design has three) the speed change can be effected on one side without interfering with the output from the other. This also applies to the changing of a worn wheel. The former job is only a question of a minute or so, but the latter involves the unscrewing of about eight bolts and so may take 10 to 15 minutes; yet, with the possible exception of when working on steel castings, this is unimportant.

A worthwhile innovation is the incorporation in a suitable position of a red lamp, which automatically indicates the approaching need to change the speed. The value for the latter, by the way is standardized as far as possible at approximately 9,000 surface ft. per minute for all three speeds. When changing speed, a lever attachment is used to lift the motor, so that the belts are not stretched; moreover the motor platforms are hinged to give automatic tensioning to the driving belts. It is interesting to note that the name plate on this well-finished machine has been cast at the Hill Top Foundry by means of the shell-moulding process.



BELGIUM has purchased for an undisclosed sum patents and plans for the newest type Diesel engines from the Baldwin Locomotive Works, Philadelphia, U.S.A. Plans have been completed for the construction of 95 Diesel-electric locomotives, costing about $20,000,000, for use in modernizing Belgium's railway system within 18 months.

Heat-treatment of Spheroidal-graphite Cast Irons*

By Marcel Ballay, Raymond Chavy and Jacques Grilliat

Spheroidal graphite cast irons are often used in the annealed condition. This "ferritizing" treatment makes them very ductile, but it is not the only heat-treatment which can be applied to them. Made up, as they are, of a matrix of steel and spheres of graphite, they lend themselves to most of the treatments used for steels. In many cases, existing knowledge relating to the heat-treatment of steel and grey iron can be directly applied to S.-g. irons.

The object of this paper is to indicate the diversity of the treatments which can be applied to S.-g. iron castings, and consideration will be given to the following treatments:—(*a*) graphitization of the combined carbon; (*b*) ferritization of the pearlite; (*c*) homogenization treatments; (*d*) martensitic quench-and-tempering; (*e*) heating below the Ac_1 point; (*f*) procedures for local hardening; quenching after partial heating in the lead bath; heating by h.f. current, and flame (torch) heating; (*g*) treatment for relief of internal stress.

It is proposed to deal extensively with the better-known treatments, but the results of recent tests on treatments little utilized hitherto will be given in some detail.†

Graphitization of the Combined Carbon

Thin castings, less than 10 mm. thick, in S.-g. iron of the usual composition (about 2½ per cent. Si) generally contain cementite which has to be decomposed into graphite and ferrite (or pearlite) if a certain degree of ductility be desired in the material. In ordinary white irons, the graphite resulting from the decomposition of the cementite is generally in the form of nodules.‡ Less usually, it occurs in the form of flake (when the iron is heated near the solidus point). Exceptionally, when the sulphur content is unusually high, it can be spheroidal.

In magnesium-treated irons, the graphite, formed by the decomposition of the cementite is usually in the form of spheres.[2] This important fact must not be forgotten in considering the theory of the formation of spheroidal graphite.

J. E. Rehder[3] has indicated that the law of decomposition of cementite in cast irons can be represented as:—

$$\log t = -0.0076\,T + b,$$

T being the temperature expressed in deg. C.;
t being the time in hours taken for the total decomposition of the carbide, and
b being a constant depending on the nature and composition of the iron.

For an ordinary cast iron composition (T.C. 3.3 to 3.6; Mn 0.20 to 0.40; Si 2.25 to 3.00 per cent.) it is generally admitted that in actual practice two hours at 850 deg. C. is sufficient to decompose all the cementite present. If b be determined on the basis of these figures, the time for which the material should be held at various temperatures between 800 and 1,000 deg. C. can be calculated with the following result:—

T (temperature in deg. C.)	t (time in hrs. and mins.)
800	4.50
825	3.00
850	2.00
875	1.20
900	1.00
950	0.20
1000	0.06

These figures represent no more than orders of magnitude, since some cementite decomposes during the time necessary to reach T and also during cooling; the presence of small amounts of chromium, vanadium, (etc.) . . . can also affect the stability of the carbide. In actual practice, it is well not to exceed 900 deg. C. for above that temperature in most industrial furnaces, castings become oxidized and deformed.

The stability of the cementite certainly depends on the rate of solidification of the casting; it is different in castings of the same dimensions which have been chill-cast or cast in dry sand, etc. Rehder's formula is nevertheless useful for calculating approximately the heating period as a function of temperature for castings of uniform thickness cooled in similar moulds.

It is sometimes desired to obtain castings which are locally hard and chill-cast, the remainder of the castings being ferritic, *i.e.* resistant to impact stresses and with a good capacity for plastic deformation. This last condition necessitates heating

---

* Paper presented to the Paris International Foundry Congress

† The symbols used in this Paper for mechanical properties are:—
Tensile tests—
R Ultimate strength, kg. per sq. mm.
E_{02} Elastic limit (yield point) (0.2 per cent. limit), kg. per sq. mm
A% Per cent. elongation at fracture.
Hardness tests—
H_B Brinell Hardness $\frac{P}{d^2} = 30$.
H_V Vickers Hardness, 30 or 100 kilos load.
H_C Rockwell Hardness, C 40 or 150 kilos load.
Impact tests—
K_{NB} Toughness, kgm. per sq. cm., on an unnotched specimen 10 by 10 by 55 mm., broken on supports 40 mm. apart.
$K_{E\ 8}$ Toughness, kgm. per sq. cm., on a specimen 10 by 10 by 55 mm. with a round-bottomed notch, 2 mm. deep, of the Mesnager type.
Frémont bend tests—
RF Breaking load, in kilos, of the 8 by 10 by 35 mm. Frémont test-piece broken on supports 30 mm. apart.
*f*F Bend, in mm., at fracture, using a Frémont test-piece.

‡ In the absence of any international agreement on the subject, the authors use here (in the original) French scientific terminology "nodule" signifying a "little knot" or "blob" or "in the shape of a blob or spheroid." The graphite of black-heart malleable castings called "American," is ("nodular"). Spheroidal (or spherulitic) graphite is in the form of more or less perfect spheres. The word "ductile," meaning in French (and English) "that which can be drawn out, elongated, reduced down to wire" obviously does not apply to all S.G. irons. Ferritic S.G. irons have a certain ductility like blackheart malleable irons. Pearlitic or martensitic S.G. irons have little or no ductility. See A. Portevin.[1]

at a temperature below the Ac_1 point, *i.e.* in the region of 700 deg. C. Application of the formula given above leads to values of t between 25 and 30 hours. It is found in actual practice that a 4-hour treatment at this temperature, which is necessary for ferritizing most of the pearlite, also graphitizes a very large proportion of the free cementite of the solidified part in the vicinity of the chill mould This cementite is less stable than that remaining in a sand-casting.

In actual practice, and particularly in the case of thin castings of complex shape, precautions have to be taken in heating because at this stage the material is very sensitive to thermal shock, and may crack if castings are suddenly inserted when cold into a furnace, the interior of which is at a high temperature. In such cases it is recommended that either the casting be heated slowly, or that it be pre-heated at about 250 to 400 deg. C. before putting into the furnace, which may be at about 850 deg. C.

Austenitic Irons

Some tests have been made in order to evaluate the ease with which carbides will decompose in an austenitic S.-g. iron containing:—

T.C. *circa* 3.0; Si 2.98; Mn 3.07; Ni 15.36; Cu 0.08; and Cr = 1.85 per cent.

Cast in a keel block (keel thickness 25 mm.), this iron consists of spheroidal graphite, austenite and about 20 per cent. carbides. Two-hour treatments were given at 1,000, 1,100 and 1,150 deg. C. respectively, followed by cooling in air, the results being as follow:—

Condition.	Brinell Hardness.	Microstructure.
As cast	180	20% carbides
Heated 2 hours at 1,000 deg. C.	176	10% carbides
Heated 2 hours at 1,100 deg. C.	186	5% carbides
Heated 2 hours at 1,150 deg. C.	238	10% carbides (network)

Part of the carbide is certainly destroyed by being heated at 1,000 and 1,100 deg. C. At 1,150 deg. C. fusion starts, with recrystallization of the carbide in the form of a network, and increase of hardness.

Ferritization of the Pearlite

In the as-cast condition, S.-g. irons consist of pearlite, with or without ferrite. When the castings are 10 mm. thick or less, they may also contain some cementite which, as has been seen, can be decomposed by heat-treatment at about 850 deg. C. To obtain high values of elongation in tensile fracture the matrix must be ferritic. The problem, therefore, is to decompose the pearlite into graphite and ferrite. Two types of heat-treatment can be employed:—(*a*) Prolonged heating below the Ac_1 point, and (*b*) Heating above the Ac_1 point, or even above the Ac_3 point, followed by slow cooling. These two types of treatment can, furthermore, be combined. Thus cycles of treatment as shown diagrammatically in Fig. 1 are given.

Heating below the Ac_1 point.

Most S.-g. irons have their Ac_1 point between 730 and 760 deg. C. (4). The higher the temperature (in practice, the nearer to the Ac_1 point), the more rapidly is the pearlite destroyed. Rehder's formula also seems to apply here, but the co-efficient T and the constant b have to be determined in each case. The distance desirable between the Ac_1 point and the heat-treatment temperature T depends on the furnace employed, on the uniformity of the temperature on the hearth, on the accuracy of the regulator, etc. It is also known that increase in the manganese content of the iron, the presence of chromium, etc., make annealing more difficult.

The rate of softening for a given temperature of heating depends on the initial condition of the iron. It varies with the fineness of the pearlite; it is greater when starting with irons containing martensite obtained by austenitization followed by an oil quench. The following are some results obtained on two S.-g. irons of the two different compositions indicated:—

Iron.	Si	Mn	Ni	As cast.	
				Micro-structure.	Brinell Hardness.
Cast 2450	2.65	0.29	2.0	Pearlite	299
Cast 2565	2.10	0.12	2.11	Pearlite	302

Specimens of these two irons were heated at 720 deg. C. for one hour, then for two hours more, starting from the following conditions:— as-cast; cooled in still air after being heated for 30 minutes at 875 deg. C. (normalized); oil-quenched after being heated for 30 minutes at 875 deg. C.

	Initial condition.	Brinell Hardness.	Heated 1 hr. at 720 deg. C. B.H. No.	Heated for 1 hr. + 2 hr. at 720 deg. C. B.H. No.
Cast 2450	As cast	299	282	262
	Normalized	320	280	270
	Oil-quenched	594	224	208
Cast 2565	As cast	302	262	209
	Normalized	320	256	200
	Oil-quenched	620	222	181

Oil-quenched irons thus soften more rapidly than as-cast or normalized irons Rehder (3) has indicated the presence of fine particles of graphite in ferrite resulting from the tempering of martensite.

It is unnecessary to enlarge on ferritizing by heating below the Ac_1 point, as the process is well known, beyond stating that the rate of cooling below 700 deg. C. has little effect on hardness and tensile properties, but it can affect impact properties, as will be shown later. Rapid cooling after heating can also set up internal stresses in the castings.

Heating above the Ac_1 point followed by slow cooling.

When the castings include thin sections containing carbides, the first stage of heating above the Ac_1 point (850 to 875 deg. C.) can advantageously be followed by slow cooling. If the castings do not contain any carbides, there is no point in going beyond the Ac_3 point and a temperature between the Ac_1 and Ac_3 points is to be preferred, so that the risks of oxidation and deformation of the castings may be lessened.

Table 1 gives some examples of treatments under these conditions. It is plain that, as in B and C in Fig. 1, slow cooling can be stopped below the Ar_1 point and the temperature of the furnace raised again, to be held for some hours at a temperature below the Ac_1 point.

TABLE I.

—	Brinell Hardness.	Tensile. R.	0.2 per cent.	A per cent
Iron 2520 (Si 2.56; Mn 0.25; Ni 1.81)				
As cast	300	69	60	1.2
Heated at 80 deg. C. per hour to 680 deg. C.; 3 hours at 680 deg. C.; cooled 28 deg. per hour to 580 deg. C., then air cooled	200	56	47.8	11.5
Iron 2525 (Si 2.35; Mn 0.22; Ni 1.51)				
As cast	293	77	61	1.7
Heated at 80 deg. per hour to 850 deg.; 1 hour at 850 deg. C. and cooled at 28 deg. per hour	192	56.5	43	16.5
Iron 2527 (Si 2.99; Mn 0.24; Ni 1.89; Mg 0.27)				
As cast	215	74.1 to 76.2	63.2 to 60.9	2.6 to 3.0
Heated at 80 deg. C. per hour to 700 deg. C.; 3 hours at 700 deg. C., cooled 28 deg. per hour	201	56.2	50.5	9.3
Heated at 80 deg. per hour to 850 deg.; 1 hour at 850 deg.; cooled 28 deg. per hour	198	55.8	46.4	11.5
Heated at 80 deg. per hour to 800 deg. C.; 2 min. at 800 deg.; cooled at 28 deg. per hour to 730 deg.; 5 hours at 730 deg.; cooled 28 deg. per hour	200	53	45.6	10.8
Heated at 80 deg. per hour to 850 deg. C.; 1 hour at 850; cooled 28 deg. per hour to 720 deg.; 12 hours at 720 deg.; air cooled	188	53.4	46	14.4
Heated at 80 deg. C. per hour to 850; 1 hour at 835 deg. C.; cooled 180 to 200 deg. per hour from 835 deg. to 800 deg. C.	239	66.4	55	5.5
Iron 2565 (Si 2.10; Mn 0.12; Ni 2.11)				
As cast (6 tests)	278 to 290	79 to 85.7	55.5 to 62	1.5 to 3.2
Heated 1 hour to 850 deg.; cooled at 150 to 175 deg. C. per hour (6 tests)	237 to 244	66.7 to 73.1	50.3 to 52.6	5.0 to 7.1
Heated 1 hour at 850 deg.; cooled at 28 deg. per hour (6 tests)	193 to 196	57.1 to 59	44.6 to 46.2	13.0 to 15.2

Partial Ferritization of S-g. Irons

In order to produce a certain capacity for plastic deformation; wear-resistance and hardness greater than those of completely ferritic irons, one may try to retain a certain proportion of pearlite. The French Tentative Specification provides for ferritic/pearlitic cast iron of type B that gives B.H. = 200 to 240; T.S. = 50 kg. per sq. mm.; Yield = 38 kg./per sq. mm.; Elongation = 5 per cent. This type of iron can be obtained under certain conditions in the as-cast state, but is usually the result of controlled heat-treating of a pearlitic iron or an iron containing but little ferrite has been undertaken. A careful study of this heat-treatment and some of the results obtained by the Authors will be found set out later.

A first method consists of heating below the Ac_1 point, but choosing a lower temperature than that used for the complete ferritizing treatment, so as to be able better to regulate the duration of the treatment. In this way, satisfactory precision can be achieved by treating, at the same time as the castings, test pieces from the same cast and of thicknesses approximating to those of the casting. A sample is taken out of the furnace, for example, after it has been held for two hours at the selected temperature, and its hardness is tested. If the hardness be higher than that corresponding to 5 per cent. elongation under the tensile test, the heat-treatment of the castings is continued and, one hour later, another sample is taken and hardness-tested, and so on until the desired hardness is obtained. The adjustment can, furthermore, be made in advance at the laboratory.

Portions of keel blocks of an iron containing T.C., 3.08; Si, 2.10; Mn, 0.12; P, 0.04; Ni, 2.11; and Mg, 0.082 per cent from cast No. 2565 were heat-treated for different periods at 680 deg. C. These samples weighed about 50 grams and were put into the hot furnace in such a way as to heat up rapidly. After periods of heating varying from one to seven hours they were taken out of the furnace and cooled rapidly in still air or left in the controlled furnace to cool at 28 deg. C. per hour.

The hardnesses obtained were:—

Initial Brinell Hardness of the sample (750 kg./5 mm.)	Holding time at 680 deg. C. (hours).	Method of cooling the sample.	Brinell Hardness (750 kg./5 mm.) after heat-treatment.
295	1	Still air	282
297	1½	—	275
295	2	—	267
295	2	Furnace (28 deg. C. per hr.)	263
298	4	Still air	246
302	6	—	236
302	7	—	221
302	7	Furnace (28 deg. C. per hr.)	218

It will be noticed that hardness is but little affected by the rate of cooling after a heat-treatment at 680 deg. C., in spite of the wide variation of the conditions of cooling chosen (air-cooling of a 50 gram specimen and furnace cooling at 28 deg. C. per hour).

The data concerning heat-treatment having thus been determined, there were chosen for heat-treatment some tensile test-pieces, the conditions giving a hardness of 230 to 240 Brinell, *i.e.*, 680 deg. C. for six hours. After this treatment, followed by cooling at 28 deg. C. per hour, the following properties were obtained:—

H_B=232 R=68.3 E(0.2%)=48.7 elongation=7.6%
H_B=238 R=69.2 E(0.2%)=47.2 elongation=5.6%

A second method consists of heating the iron to about 850 deg. C. and controlling the rate of cooling

between this temperature and about 650 deg. C. Table 1 contains examples of such treatments in the case of irons from casts No. 2527 and 2565. It is of course understood that the two methods can be combined (see Fig. 1, curves B and C).

Homogenization Treatments

The heat-treatment of steel castings comprises, as a rule, a high-temperature treatment at about 1,000 deg. C., the object of which is to reduce or eliminate such heterogeneity of composition as is caused by the process of solidification. This treatment, called "homogenizing," noticeably improves the mechanical properties of the casting. It occurred to the Authors to speculate upon what the results would be if this treatment were applied to S.-g. irons, more particularly since some of these irons show marked heterogeneity in their matrices when examined under the microscope. The Authors have frequently noted this, and Wittmoser has commented on it.

Thus tests were made with three irons, the treatments being carried out on samples taken from keel blocks.

Table II refers to an iron containing 0·81 per cent. manganese, and from it will be seen that elongation figures and impact strengths have been improved by heating at 1,000 deg. C. for two hours; this treatment brings about a thinning-down of the network of segregates, shown up by the microscope after etching.

TABLE III.

	Brinell hardness.	Tensile. R.	Tensile. E 0.2 per cent.	Tensile. A, per cent.	Shock test, K.N.B.
Iron 2505 (Si, 3.58; Mn, 0.57; Ni, 2.57).					
As cast	227	—	—	—	—
Heated for 2 hr. at 725 deg., cooled in furnace	230	62.3 63.3	54.5 55.0	5.9 6.3	— —
Heated for 6 hrs. at 740 deg., cooled in the furnace without prior treatment	223	56.6	50.6	4.3	2.7–1.6
After heating to 1,000 deg. for 2 hr. and cooling in still air	208	58.9	50.2	8.6	2.4–3.9
Iron 2528 (Si, 3.07; Mn, 0.32; Ni, 1.97).					
As cast	261	68.5 70.0 70.0 71.3	59.5 59.5 59.7 61.3	2.0 2.5 1.4 1.9	— 0.8 0.9 —
Heated for 3 hrs. at 700 deg., cooled at 28 deg. per hr., without prior treatment	211	57	50.5	8.2	3.7
After heating for 2 hr. at 1,000 deg. and cooling in still air	207	57.4	48.5	9.3	10.0

Such homogenization treatment has much less effect, or even none at all, when the content of manganese is lower than in the last-mentioned case. It can also be masked by differences in hardness. The results obtained on two other irons are shown in Table III. It thus appears that homogenization improves elongation under the tensile test, as well as impact strength, the effect increasing as the manganese content is raised. The improvement is associated with the disappearance or thinning out of a network shown up under the microscope owing to its greater vulnerability to etching reagents.

Normalization

This treatment is mentioned here although, strictly speaking, it is not a homogenization treatment. It consists of heating the iron—like steels—above the Ac_3 point and allowing it to cool in still air after a sufficiently long holding period at the austenitizing temperature. The effectiveness of this treatment depends on the section thickness of the castings, which governs the rate of cooling. As applied to plain or only slightly alloyed irons, it differs from martensitic quenching in that it produces a more or less fine pearlitic structure. In high-alloy irons, the alloy additions of which lower the critical rate of the quenching, martensite would obviously be produced.

TABLE II.

—	Brinell Hardness.	Frémont Bend. RF.	Frémont Bend. fF.	Tensile. R.	Tensile. Ed 0.2 per cent.	Tensile. A per cent.	Shock test.
As cast	310	1600 1800	0.2 0.2				
Heated 7 hours at 700 deg. C., cooled in the furnace	296	1540 1500	0.2 0.2				
Heated 6 hours at 760 deg. C., cooled in the furnace	222	1850 1850	2.5 2.5				
Heated 6 hours at 740 deg. C., cooled in the furnace							
Heated 6 hours at 740 deg. C., cooled in furnace without prior treatment	224			60.8 60.0	59·0 58.6	1.2 1.0	0.9
After heating at 1,000 deg. for 2 hours and cooling in still air	221			60.0 60.0	53.3 52.6	8.3 11.0	2.2

Millis[6] has published the following results of normalizing castings 12½ mm. thick for 1 hour at 870 deg. C.:—

Casting.	T.S.	Y.P.	Length.	B.H.
Normalized, not re-heated	99.4	67.2	7.5	265
Normalized, tempered at 590 deg. C.	95.2	67.2	7.5	273
Normalized, tempered at 650 deg. C.	94.1	63.7	8.0	257

In addition to improving the mechanical properties of the castings, this treatment is suitable when it is desired to harden a ferritic or ferritic/pearlitic iron.

Martensitic Hardening and Tempering

S.-g. irons are very well adapted to hardening and tempering. There are several references to this in technical literature 2, 3, 6, 8, and the subject will be confined to stating the potential usefulness of irons so treated. Irons without alloy additions can be made martensitic by oil-hardening or water-quenching after being heated to 875 to 850 deg. C. (according to the silicon content). Silicon raises both the Ac_1 point and the Ac_3 point. When the Mg addition is made by means of a Ni-Mg alloy, the Ni thus added has an opposite effect to that exerted by the silicon; the same applies to manganese.

Hardness, after quenching in oil or water, varies between 850 and 600 Brinell. The period of heating before quenching—necessary in order to obtain martensite—depends on the microstructure of the iron; it is obviously longer for a ferritic than for a pearlitic iron, since it is necessary to dissolve and diffuse the carbon in the matrix of the ferritic iron in order to form an austenite of sufficiently high carbon content.—This is shown by Table IV, which

TABLE IV.

Time of rise from 20 to 850 deg. C. Minutes	Time held at 850 deg. C. Minutes	Brinell Hardness 750 kg./5 mm. (tungsten-carbide indenter).	
		Initial state Pearlitic.	Initial state Ferritic.
50	30	603	508
36	15	606	439
20	1	591	293

gives the hardness values of samples from a given iron (Si 2.10, Mn 0.12, P 0.04, Ni 2.11, and Mg 0.082 per cent) heat-treated from the as-cast condition, with an initially pearlitic matrix, or ferritized. These samples were heated at 850 deg. C., held at this temperature for different periods, one to 30 minutes, and quenched in oil.

One should take account of these observations in order to interpret the results of rapid heating, as, for example, when there is local hardening by flame or high frequency current. Although there is not much information on this point, it would seem that S.-g. irons should be susceptible to isothermal hardening, like irons with flake graphite and steels of similar compositions. As in the case of steels, tempering increases ductility. A temperature of at least 450 deg. C. is usually desirable, to reduce the (internal) stresses resulting from hardening.

With a view to lessening deformations due to quenching and the risk of cracking, it is possible to cool down to about 700 deg. C., before quenching, castings of ordinary composition austenitized at 850 deg. C. Table V gives some data on samples of a single iron (T.C. about 3.3, Si 2.10, Mn 0.12, P 0.4, Ni 2.11 and Mg 0.082 per cent.), as-cast (pearlitic — H_B = 300) or in the ferritic state (heat-treated — H_B = 180). The specimens were austenitized by heating at 850 deg. C. for 30 minutes. They were then cooled slowly, at 5 to 6 deg. C. per minute, in a furnace, before being oil-quenched at 800, 750, 700 and 650 deg. C.

TABLE V.

Quenching temperature, deg. C.	Brinell Hardness, 750 kg./5 mm. (tungsten-carbide ball).	
	Initial state before quenching: Pearlitic.	Initial state before quenching: Ferritic.
850	603	508
800	601	—
750	604	547
700	592	536
650	252	233

Apart from the fact that this iron can be cooled to 700 deg. C. before oil-quenching and still produce martensite, it will be noted that the hardness values obtained are always lower when the iron is ferritic as-cast. The suitability of an iron for this delayed quenching obviously depends on its chemical composition, particularly on its contents of nickel and manganese..

In what has gone before, the Authors have regarded hardening as the typical effect of quenching, but the tensile strength and elastic limit, the transverse strength and compressive strength are also increased by comparison with their values in pearlitic material. Nevertheless the relationship between hardness and tensile strength, for example, is somewhat wider in the hardened and tempered state than in the pearlitic or ferritic states.

In Table VI[6] the tensile properties are plotted against the hardness values obtained by three authorities, the tensile strengths being probably the highest yet published. It will be noticed in particular, that there is a strength of 152 kg. per sq. mm. with a Brinell hardness of 418, a combination of values not very different from those obtained with forged steels; ductility, of course, as represented here by elongation, is lower than with ordinary cast iron.

TABLE VI.

Brinell hardness.	Reheating temperature after quenching, deg. C.	R.	E.	A, per cent.	Authority.
507	350	134	134	—	Ballay, Chavy, Grilliat[8]
418	430	152	129	1	Shelley.
402	402	137.2	84.7	2.5	Rote and Conger[7].
351	540	112.7	103.2	1.5	Shelley[7].
302	480	107.4	91.7	1.5	Shelley[7].

The scatter in the values of tensile strength as a function of hardness appears to the authors to be attributable to several causes: (*a*) premature fractures due to low capacity of the material for deformation and to imperfect specimens; (*b*) composition of the iron; (*c*) differences in the conditions of heat-treatment; (*d*) "quality" of the iron, a vague term referring to factors which cannot, it may be assumed, be measured. To take an example, attention is drawn to the fact that the strength R = 152 kg. per sq. mm. obtained by Shelley[7] with H_B = 418 was found in an iron which, in the as-cast condition, had excellent properties (R = 68 kg per sq mm, 10 per cent elongation) which, at least in France, are not often obtained.

In the case of large castings or castings of medium

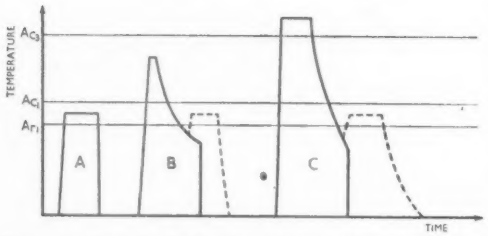


FIG. 1.—*Graphs indicating the principal ferritizing treatment for S.-g. irons.*

thickness but complex shape, oil or water-quenching is usually not possible because either martensite would not be produced or cracks would ensue. What is required, therefore, is to lower the critical rate of the quench by adding nickel or molybdenum or both together. Up to a certain point manganese acts like nickel, but has to be used carefully because it seems to accentuate the primary heterogeneity of the matrix and causes a certain degree of brittleness. Chromium is difficult to use because it produces fairly stable carbides which are detrimental when the castings have to be machined.

The problem of self-hardening S.-g. irons was outlined in a paper[8] presented to the International Foundry Congress at Brussels in 1951. It may be of interest to indicate some of the applications to which these French-made irons have been put since that date by one of the present authors.

Camshafts are made of self hardening Ni-Mn-Mo iron. In the as-cast condition they are unmachinable. They are therefore annealed at 650 to 700 degrees C., this bringing their Brinell hardness to between 280 and 320. The castings are then machined except for those parts requiring correction, on which 0.3 mm. of excess thickness is retained. The cams could be hardened by flame or by high-frequency current, but it seemed simpler and more economical to cool the whole shaft in still air after heating it to 900 to 920 deg. C. This quench is followed by a tempering at 250 to 300 deg. C., which relieves the stresses without lowering the Brinell hardness, which may vary, according to the chemical composition and the rate of cooling, between 480 and 550. These shafts give excellent service, comparable with that of case-hardened and quenched steels.

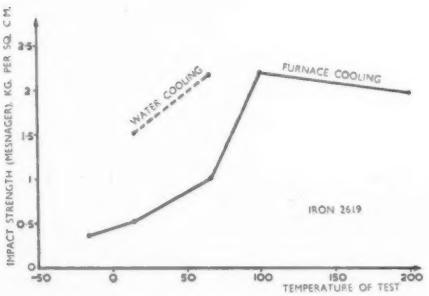
Another application is plates of impellers for handling abrasive materials. These machines circulate water charged with ground superphosphates and also containing flints and other abrasive rocks. Impeller plates, previously made in cast or welded steel, showed heavy wear and have been replaced by S.-g. Ni-Mn-Mo—hard in the as-cast condition—annealed before machining and then cooled in still air after being heated at 900 to 925 deg. C., yielding a Brinell hardness of about 550. The results in service have been noteworthy, the increase in life being more than 10 times that of the components formerly made of mild or medium steel.

An iron of identical composition has also given very interesting results in components intended for grinders of household garbage. The machine has been used experimentally for several days for grinding scraps of glass and bone without either the "crown" or the "plate" showing any appreciable wear. There is also the adaptation of the same type of self-hardening iron to the manufacture of pump parts (main structure and gearing) intended for the handling of liquids containing metallic particles. The components when made of carburized steel wore out very quickly, and their replacement by S.-g. iron treated to 500 Brinell has resulted in a greatly enhanced service life. The user of these parts has standardized on this material as a solution of his problem.

Effect of Cooling Rate and Duration of Heating Below the Ac_1 Point

Earlier it was pointed out that after the ferritizing treatment (heating below the Ac_1 point), S.-g. irons could be cooled rapidly or slowly without the cooling rate affecting the hardness or the tensile properties. It has been observed, however, that the impact strength, *i.e.*, the work of fracture by simple shock, of a notched specimen, depended on the rate of cooling in certain irons. Since this phenomenon is still not too well known, its effect will be shown by means of some examples.

Experiments were made with Mesnager test-pieces (round notch 2 mm. deep) broken on a Charpy-machine at −18, 15, 60, 100 and 200 deg. C. After heating at 700 deg. C., certain test-pieces were cooled suddenly by immersion in water, while others were cooled slowly in the furnace at a rate of 150 deg. C. per hour.



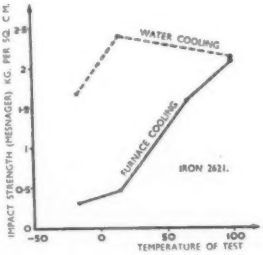


FIG. 2 AND 3.—*Mesnager impact values for irons* 2619 *and* 2621 *respectively, cooled rapidly or slowly after being heated at* 700 *deg. C. Test temperatures between* −18 *deg. C. and* +200 *deg. C.*

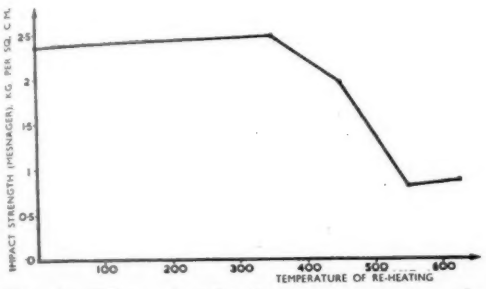


FIG. 4.—*Effect of re-heating temperature on the Mesnager impact strength of iron* 2621 *previously heated at* 700 *deg. C. and water-quenched. Test temperature* 15 *deg. C.*

Iron 2619

T.C., 3.45; Si, 2.62; Mn, 0.27; S, 0.010; P, 0.043; Ni, 2.06; Cu, 0.05; and Mg, 0.081 per cent.

The curves in Fig. 2 show clearly the improvement in resistance to shock produced by quenching in water after the ferritizing heat-treatment.

Iron 2621

T.C., 3.42; Si, 2.50; Mn, 0.27; S, 0.007; P, 0.057; Ni, 2.16; Cu, 0.04; and Mg, 0.057 per cent.

The curves in Fig. 3 also indicate the better impact strength in the iron which was water-quenched after being heated at 700 deg. C. Starting with iron water-quenched from 700 deg. C., the impact strength of test-pieces heated for 8 hours at 350 deg. 450, 550 and 625 deg. C., and furnace-cooled slowly before being broken at 15 deg. C. was determined. Fig. 4 shows that heating between 450 and 550 deg. C. produces a lowering in impact value. After annealing at 550 deg. C., the impact value approaches that of the iron which was slowly cooled from 700 deg. C.

Iron 2678

T.C., 3.56; Si, 2.55; Mn, 0.18; P, 0.04; Ni, 1.5; and Mg, 0.12 per cent.

As is shown in Table VII, the impact strength at −18 deg. C. and at 15 deg. C. of this iron when furnace-cooled slowly is no different from that of the rapidly, water-quenched iron. Gilbert[9] has studied in great detail the mechanism of fracture by static bending and by impact bending in ferritic S.-g. irons. He has shown clearly the displacement

TABLE VII

Brinell Hardness.	Testing temperature (deg. C.).	Mesnager impact strength K E2 (kgm./cm.²).
Annealed .. Furnace cooling at 150 deg. C./hr. 176–178	− 18	2.1—2.3
	+ 15	2.3—2.2
	+100	2.2—2.3
Annealed water-quenched .. 177–185	+ 15	2.2—2.3

of the transition curves produced by the thermal history of the material below the Ac_1 point. His paper is the most exhaustive that has so far been published on this subject. It seems that the known facts regarding the effect of heat-treatment on the brittleness of ferritic S.-g. irons can be summarized as follows:—

Certain irons, which designated "susceptible," have lower impact strength after slow-cooling (150 deg. C. per hour, for example) than after rapid cooling from 690 to 720 deg. C. A susceptible iron that has been made brittle by slow cooling can be regenerated by heating for 1 hour at 700 deg. C. and then cooling rapidly by means of a water-quench (700 deg. C. per minute).

An iron which is susceptible but is in the tough state can be made brittle by heating it for 1 hour in the range 350 to 550 deg. C. The rate of cooling after this heating has merely the effect of prolonging its duration in the harmful range of temperature. Water-quenching after such a heating does not seem to have any particular effect.

The fundamental reason for these phenomena, which would appear to have some relationship with temper brittleness (Krupp krankheit), has not so far been elucidated. Gilbert, indeed, indicated the very marked influence of silicon and phosphorus but, in certain cases studied by the Authors, large differences are found in materials having practically the same contents of these elements and chemical analysis has not furnished any explanation, nor has spectrographic analysis enabled the Authors to associate this brittleness at all certainly with variations in the contents of titanium, lead, zinc or tin. It should be noted, finally, that "susceptibility" is revealed particularly by notched specimens. It is much less marked in un-notched specimens.

REFERENCES

[1] A. Portevin, "Spheroidal Cast Irons," *Metal Progress*, 1951, vol. 600 p. 82 (December).
[2] J. W. Grant, "Nodular Structures of Chilled Magnesium and Cerium Treated Irons after Heat-treatment," B.C.I.R.A. *Jnl. Res. & Develop.*, 1950, vol. 3, pp. 571-574 (October).
[3] J. E. Rehder, "Annealing and Heat-treatment of Nodular and Other Cast Irons," *Mémoires du Congrès International de Fonderie*, Bruxelles, 1951, pp. 313-324.
[4] M. Ballay, R. Chavy and J. Grilliat, "Etude de Quelques Propriétés de Fontes à Graphite Sphéroidal" (study of some properties of S.G cast iron), *Fonderie*, 1951, No. 68, pp. 2589-2604 (August/September); No. 69, pp. 2636-2651 (October); discussion, pp. 2651-2652.
[5] A. Wittmoser, "À Propos de la Formation des Nodules de Graphite" (on the formation of nodular graphite), *Memoires du Congrès International de Fonderie*, Bruxelles, 1951, pp. 433-450.
[6] K. D. Millis, "Heat-treatment of Ductile Cast Iron," *Metal Treating*, 1953, vol. 4, pp. 6-8 (January/February).
[7] J. D. Sheley, "Ductile Iron Replaces Alloy Gear Castings, Forgings," *Iron Age*, 1951, vol. 167, pp. 99-100 (May 10).
[8] M. Ballay, R. Chavy and J. Grilliat, "Etude de Quelques Fontes Alliées Autotrempantes à Graphite Spheroidal" (study of some self-hardening S.-g. alloy cast irons), *Memoires du Congrès International de Fonderie*, Bruxelles, 1951, pp. 325-338.
[9] G. N. J. Gilbert, "Ductility of Ferritic Nodular Iron," B.C.I.R.A *Jnl. Res. & Develop.*, 1953, vol. 4, pp. 458-478 (February).

(*To be continued*)

A BRANCH OFFICE of Head, Wrightson & Company, Limited, engineers, iron and steel founders, etc., of Thornaby-on-Tees, has been opened at 7, The Side, Newcastle-upon-Tyne, 1. Mr. F. C. Wake, recently Regional Controller of the Ministry of Supply, is in charge.

THE FIRST of 48 Diesel-electric locomotives, the biggest contract of this description handled by Metropolitan Vickers-Beyer Peacock, has been despatched from Stockton-on-Tees on the first stage of an 11,000-mile journey to Australia. The 51-ft. long engine, weighing 77 tons, is being taken by road to Liverpool for shipment; it is expected that the road journey will take seven days. Completion of the full contract is not due until the end of 1955.

Notes from the Branches

Birmingham

At the annual dinner of the Birmingham, Coventry and West Midland branch of the Institute of British Foundrymen in Birmingham on January 22, Dr. J. E. Hurst, a past-president of the Institute reminded members that the Institute had been founded in Birmingham on April 9, 1904. The branch was the second largest in the world, but it had, he claimed, never been second in importance.

Mr. T. H. Taft, the branch-president, replied to the toast to the Institute proposed by Dr. Hurst and outlined the progress which the organization had made in 50 years. The president of the Institute, Mr. E. Longden, responded to the toast to the guests, proposed by Mr. N. C. Blythe.

Scottish—Falkirk Section

This section of the Institute held a meeting last month with Mr. James Ferguson, of Lane & Girvan, Limited, in the chair. Mr. R. R. Taylor, of Muirhall Foundry, Larbert, spoke on the subject of "Factors Influencing the Quality of Iron Castings." He dealt with many matters of interest to those engaged in the industry. Mr. Taylor's firm specializes in high-duty iron castings and he introduced his subject under the four headings, soundness, metallurgical suitability, dimensional accuracy and appearance. The methods employed to achieve a high degree of satisfaction under each heading were dealt with in turn, the talk being exceptionally well illustrated with slides. A short discussion followed and the meeting concluded with the chairman proposing a vote of thanks.

Beds and Herts Section

The January meeting of the Bedfordshire and Hertfordshire section of the London branch of the Institute of British Foundrymen was held in the canteen of W. H. Allen, Sons & Company, Limited, Bedford, by kind permission of the directors, with Mr. E. Daybell presiding. There were 65 members and visitors present. Mr. A. F. Stevens introduced a film "Modern Malleable," which was extremely interesting and attracted a great many comments and questions. Bedfordshire is the home of two progressive malleable-iron foundries, representatives from which turned up in force and joined in a debate not only with the introducer and chairman but among themselves. Mr. G. R. Webster, a past-president of the London branch, thanked the speakers and stated his pleasure at finding a section in the district. Mr. H. W. Keeble seconded the vote of thanks.

Tees-side

The last three meetings of the Tees-side branch of the Institute of British Foundrymen have been extremely interesting and well attended. There is an increasing number of new members and the popularity of the branch seems to be well maintained. Mr. T. Hurst of Darlington Forge gave a very interesting lecture on the reduction of costs of castings by careful planning. This aroused considerable interest amongst the many steel and iron founders present. In December, three members of the branch Council provided a "How to make it" programme for the evening. Mr. P. Pennington, Mr. D. W. Atkinson and Mr. T. Wolverson were each presented with a pattern and a drawing and were asked how they would proceed to make the casting desired in iron, steel, and non-ferrous metal. Their accounts lasted only for 10 min. each and were illustrated with slides. After these had been given, the lecturers had to withstand a barrage of questions from branch members, who readily found reasons to differ from the opinions given regarding the correct technique to be adopted.

In January, Mr. J. R. Charlton gave his paper "Production of Diesel-engine Castings in Grey Iron," which he previously read at the annual conference in 1953, and exhibited some excellent slides showing the method of production of these large castings. Whilst members felt that Mr. Charlton had covered the ground very carefully, there were still a large number of questions as to the reason for the adoption of certain methods.

Latest Foundry Statistic

According to the British Iron and Steel Federation, employment in ironfoundries increased towards the close of last year, so reversing previous trends. On November 7 the total was 140,714 as against 140,301 in October, the increase being made up of 303 men and 110 women. The steel foundries, however, showed a loss, there being (at 20,504) 51 fewer than on October 10. In this case the decrease was 141 men and gain of 90 women.

The average weekly melt of steel for making castings during November was 11,300 tons as against 11,400 tons in October and 11,700 in November, 1952. Of the November melt 2,880 was alloyed. For the first 10 months of last year, the weekly average production was 5,900 tons, so that the probable year's output should be a matter of simple calculation.

During the first 11 months of last year, the ironfoundry industry exported about 136,500 tons of pipes and fittings, whilst for iron castings there are two headings, the second of which is bracketted with forgings. The first quotes an annual figure of the order of 770 tons and the second 4,070 tons. The output of pig iron for the year was 11,175,000 and that of steel ingots and castings 17,624,000 tons.

Collection of Statistics

Responsibility for collection of the statistical returns relating to iron foundries, which has hitherto been vested in the Ministry of Supply (Iron and Steel Division), is being transferred to the Iron and Steel Board. For monthly and quarterly returns, the change took effect for the period ending January 2, 1954. For weekly fuel returns, the change took effect for the period ending January 9, 1954. With the forms for these periods, ironfounders will probably, by now, have received a letter from the Iron and Steel Board informing them of the change.

Pig-iron Prices

Price control has now become the responsibility of the Iron and Steel Board, who have issued Iron and Steel Notice No. 2 of 1953, announcing the determination of maximum prices for 23 schedules of products. These include five classes of pig-iron as follows (the number of the "related schedule" appears in brackets after the name of each class):—Basic and hematite (No. 1); foundry and forge (No. 2); low-phosphorus foundry (No. 3); Scotch foundry (No. 4), and cylinder and refined and refined malleable (No. 5). The remander of the schedules relate to steel products.

The "related schedules" are obtainable, price 1s. 6d. each, post free, from the Iron and Steel Board, prices department, Norfolk House, St. James's Square, London, S.W.1. The "price determination" costs 6d., post free. Remittances should accompany orders.

Foundry "Brains Trust"

The West Riding of Yorkshire branch of the Institute of British Foundrymen recently held a "Brains Trust" for which the members of the panel consisted of Mr. H. Forrest (question master), Mr. Bolton, Mr. Allard, Mr. Kershaw, and Mr. Simpson. The following is an abridged account of the proceedings:—

Question 1.—"C" and "D" Processes

Is the "C" process already outmoded by the "D" process? Secondly, is the backing-up of shell moulds by shot a retrograde step?

MR. FORREST to assist the team said that the "D" process owned its name to Dietert, the well-known American sand expert who had developed a method of producing shell-like moulds. In the process, suitable dry, silica sand was mixed with a special binder and this mixture was blown into the cavity formed between a pattern mounted on the underside of the core-blower head and a pre-heated metal "former," the cavity being arranged to give shell thicknesses of approximately $\frac{3}{16}$ in. to $\frac{1}{4}$ in. The heat from the "former" was sufficient to pre-bake the sand shell and give it enough strength to permit of its removal from the pattern. The "former" and the shell were then put through an oven and the curing process of the shell was completed. The "former" whilst still hot, was then returned to the core-blower for further investment.

MR. BOLTON said that he did not feel qualified to comment in detail as he had not made any close study of the "D" process, but it seemed to be on more conventional lines than the "C" process and a development of the commonly used core-assembly method. With regard to the backing up of shell moulds by shot, his own experience was that this was not essential, but a great deal depended on the mass of the casting and particularly on whether the moulds were cast in the vertical or horizontal position. The handling of the shot was the main problem involved and if suitable means of separating it from the sand were devised and also of returning it to suitable hoppers from which mould containers could be filled, its use might well be warranted for certain types of castings. He did not, therefore, consider the use of shot to be a retrograde step.

MR. ALLARD mentioned that there were various alternative methods of obtaining adequate support without the use of shot for heavier castings, such as bolting the two halves together, or the use of a compressed-air-clamp arrangement which accommodated the irregular surface at the back of the shells.

MR. BOLTON said that on reflection it occurred to him that backing up with shot could not be considered retrograde as it was used in the "C" process as originally formulated and, therefore, the departure in some instances from this necessity constituted a development. He said that apart from the question of physical support, the shot had an important effect in conducting the heat away from the shell mould. As a result, the solidification process was further advanced when the bond of the shell mould was broken down by the heat of the metal, than would otherwise be the case, and hence thinner shells could be used.

MR. KERSHAW commented that to him it did not seem possible to give definite answers to the question. The economic aspect was an important one, that was, how the cost of producing an adequate shell thickness compared with the cost of backing up a thinner shell.

MR. FORREST said he thought the general opinion of the team was that for the heavier types of casting backing up by some means was desirable, as there were limits to the thickness of shell which could be produced. The team were not sufficiently familiar with the "D" process to discuss its relative merits.

Question 2.—Disappearing Chills

Four solid cast-iron chills were placed in one end of a 10 in. dia. core and the core protruded into a very heavy section of metal. The core and chills appeared to strip perfectly from the iron casting, but upon examination, the chills had become mere shells of metal. What was the explanation?

MR. FORREST to assist the team said that the "D" chills were not very heavy ones, they became molten when in contact with a very thick section, and were drawn into the casting during solidification so as to become feed metal. He could not offer an explanation as to why a "shell" had been left and a good strip obtained.

MR. RAMSDEN said he had posed the question and could say by way of further amplification that the chills were almost quarter-circle segments leaving 2 in. of sand between them on the core end and they were approximately 2 in. thick. The chills stripped perfectly. As to the weight of the remnants of the chills, he estimated that there was at the most 1/10th left. The shell remnant of one chill was so thin that it fell to pieces, whilst the others varied up to $\frac{1}{4}$ in. thickness. No point where the metal "bled" into the casting could be detected.

[He illustrated his problem by means of sketches on the blackboard.]

MR. BOLTON offered the theory that the casting metal might have been lower in carbon content than the chill metal and that carbon diffused from the surface of the chills to the metal in the mould. This could have the effect of raising the melting point of the surface of the chills in contact with the metal in the mould, which might, therefore, remain solid whilst the interior of the chill became liquid and found its way in some manner into the casting.

MR. HAMMOND said he wondered if there was any connection with observations that had been made on the melting of metals. Observations made in cupolas, for instance, showed that solid lumps of iron, such as pig-iron or heavy scrap, always

Foundry "Brains Trust"

melted from their centre outwards. The rate of heat transmission through a section of metal was so high that the surface could not build up a sufficient excess of heat for melting to occur here first under these conditions of melting.

MR. FORREST, summing up, said that whilst various theories had been put forward, it appeared that the team could not be very helpful in giving a definite reason, but they and members present might have gained from the general discussion.

Question 3.—Camber

It is common practice to camber certain patterns in order to acquire a straight casting. Does moulding and casting one way up or the reverse have any appreciable effect on the amount and direction of camber required?

MR. SIMPSON, opening the discussion on this question, commented that it was rather a tricky problem and one of which he had little experience. He had never tried pouring a casting from a cambered pattern the reverse way to the normal method, for which the camber required had been obtained by experience.

MR. NICHOLLS said he felt that the question was one which could only be related to castings of individual design.

MR. KERSHAW said that the amount of camber required was dependent on the relative rates of cooling of the various sections. Castings requiring cambering were usually big jobs and 90 per cent. would be run at the bottom and this was usually the heavy section. Moulding the pattern the reverse way and running still into the bottom, would mean in that case running into the thinner sections, which would have a tendency to even out the rate of cooling of the thin and thick sections which should result theoretically in a reduction in the amount of camber required.

Upon a request being made for details of the particular type of casting, if any, that the questioner had in mind, MR. ALLARD said that as it happened, he perhaps would have to answer the question he had sent in himself. The question was a speculative one and he had felt that the camber required would be in the same direction whichever way a mould from a particular pattern were cast. The job he actually had in mind was of relatively light section and roughly rectangular in shape, 12 ft. long and 12 in. wide and with a longitudinal rib 2 in. deep. He proceeded to illustrate this by means of a sketch on the blackboard showing the direction of camber incorporated in the pattern.

MR. ANDERSON said that after seeing the sketch he felt the casting was of such thin section in relation to length and width that it was probably true that moulding either way uppermost would not alter the direction and amount of camber required.

MR. FORREST said that the opinion of the team seemed to be that the camber required was mainly a function of design and that the results to be expected from casting a cambered pattern one way up or the reverse depended largely on the individual design. It had been pointed out that the method of running could alter the rates of cooling of thick and thin sections to some extent and might, therefore, affect the *amount* of camber required. With the particular casting described, it seemed likely that the casting would probably come out straight whichever way up it was moulded.

Question 4.—Shrinkage Defects

What are the reasons for shrinkage defects occurring directly under risers and feeders in iron castings and what precautions should be adopted to prevent them?

MR. ALLARD said the reason for shrinkage under risers was that the risers solidified before the casting instead of the reverse and the remedy would be to provide a riser of larger diameter. As an alternative, a "blind" riser could be provided which did not pass through the top-part of the mould and would, therefore, tend to keep liquid longer. Probably the best method was to run further hot metal into the riser after the mould had been poured and to provide a reservoir for the overflow.

MR. BOLTON mentioned that he had had a similar problem with flywheels weighing two to three cwts., where shrinkage had occurred beneath the feeders even though the castings had been run through them. The trouble had been eliminated by reducing the silicon and carbon content of the metal slightly. The metal which gave the trouble was of rather "open grain" and he thought that the alteration in composition which gave the improvement had had the effect of widening the freezing range and thereby giving a more dispersed type of shrinkage which was not noticeable.

MR. KERSHAW felt there was no doubt that shrinkage beneath the risers was due to the riser creating a localized hot spot beneath it from which the rest of the casting could feed, but that the riser was ineffective in replacing this metal. The riser in solidifying first might actually have been fed from the casting. This sort of cavity was often aggravated by any gas trapped in the metal—in coming out during solidification, such gas had the effect of enlarging the cavity. The remedy was to proportion the risers more satisfactorily, but often this was not easy because moulding-box bars might make it difficult to provide a sufficiently heavy feeder at the required spot. He, personally, preferred side feeders, as these seemed to serve better and were less likely to give a cavity of the type described.

MR. FORREST said that the answer to the question seemed to be to study progressive solidification and to provide adequate feeders to make sure the metal was feeding into the casting and not *vice versa;* also to control the metal composition so as to give a satisfactory freezing range. He thought that with the basic principles in mind, these sort of difficulties could only be overcome in practice by trial and error, noting each cause and effect, so that one could assess the relative merits of what had been done.

Question 5.—Fluidity

What additions to a ladle should be used to increase the fluidity of cast iron?

MR. BOLTON said he would advise that the phos-

phorus content of the iron be increased by adding ferro-phosphorus. He thought, also, that there were now ladle additions available for increasing the carbon content—which again would increase fluidity. These, he believed, contained some silicon which presumably would be of additional benefit.

MR. KERSHAW thought the answer was to seek a remedy further back in the process, and to produce hotter iron.

MR. FORREST agreed, and said there were limits as to how much the fluidity of metal could be increased by ladle additions. However, the questioner was actually seeking information on increasing the fluidity of the iron after it was in the ladle.

MR. NICHOLLS said he thought the use of exothermic compounds would help.

MR. JOHNSON agreeing, pointed out that whilst exothermic compounds did not actually warm up the metal, the addition of appreciable amounts of cold material to the ladle might otherwise result in such a loss of temperature that the object of making the addition would be defeated. As far as he knew, the various agents marketed for increasing the carbon content of molten cast iron were not very effective. In general, he said, with a hypo-eutectic iron, the addition of silicon, phosphorus, or carbon (if it were possible) would result in an increase of fluidity by bringing the composition nearer the eutectic, but only provided precautions were taken to make sure the temperature losses were no greater than they would have been if the ladle addition had not been made.

Question 6.—Machining Shell-moulded Castings

What is the cost saving, if any, of using shell-moulded castings, which presumably require little or no machining, compared with castings made by ordinary methods with the usual machining allowances?

MR. FORREST, in putting the question to the team, commented that this was another question which was rather difficult to generalize upon.

MR. ALLARD said that he had had experience of small castings which were produced to an accuracy of 0.003 in.* and with which a considerable amount of machining had been saved.

MR. FORREST said he would be surprised if this sort of accuracy could be maintained across the joint of the mould.

MR. ALLARD added that with the sort of castings he had in mind, it was possible to cut out ten machining operations on one individual casting and it was in this way shell-moulded castings showed economies. The foundry production costs were certainly greater than for ordinary green-sand moulding, but he felt that savings to be obtained in machine-shops outweighed this.

MR. BOLTON commented that if a shell-moulded casting had to be machined at all, it seemed to him that, generally speaking, it would prove more expensive than an ordinary green-sand moulded casting of a similar type.

MR. NICHOLLS said he felt that the possible savings depended very much on the "overheads" of a particular machine-shop. In some shops the cost might be 7/6d. per hour, but next door it could be 25/- per hour, on the same component.

MR. FORREST largely agreed with Mr. Bolton that if the castings were produced without the necessity for machining, there would be a saving, but that if even a grinding operation were necessary, there was not the same likelihood of economy. For instance, for the automobile trade machine-moulded castings were regularly being produced with $\frac{1}{16}$ in. machining allowance and this was removed in one operation. In these cases, to achieve a saving it seemed that the shell-moulded casting would not have to be machined at all.

He felt there had been a lot of loose talk about the limits which could be worked to in shell moulding. Maintaining an accuracy across the mould joint comparable with that obtained in the other direction was one of the difficulties. When people spoke of an accuracy of 0.003 in. across the joint it seemed to him that they did not know what they were talking about. Taken over a large surface it seemed to him to be a very remote possibility that anyone could guarantee a dimension to 0.003 in.

MR. NICHOLLS said that savings could possibly be realized where adequate accuracy could be obtained in a shell-moulded casting to eliminate the necessity for machining operations on those dimensions which were scheduled as "clearance" fits, even if the dimensions involving closer tolerances still required the same expenditure in machining as the corresponding green-sand-moulded casting. With regard to the question of obtaining accuracy across the joint by eliminating flash, an eminent American firm kept the variation across the joint on one type of casting down to 0.001 in. by treating one half of the shell with resin adhesive and clamping the two halves together firmly when hot. The clamps were not released until the shell had cooled down.

MR. FORREST reiterated that while allowances could be made on the pattern for the more consistent deviations, such as metal shrinkage, he was firmly of the opinion that general statements as that casting tolerances could be held to the order of 0.003 in. should not be taken too literally, and it was wrong to lead engineers to believe that this accuracy could be generally maintained. A figure of 0.003 in. was a very small measurement when considered in terms of casting accuracy. It was possible, he said, to obtain a variation in size of this order due merely to the difference in casting temperature between the beginning and end of pouring of a metal ladle, owing to a different amount of contraction. In his opinion, it did individuals and the foundry industry in general harm to claim to be able to produce something which it was not possible to achieve under practical and repetitive conditions.

Concluding the discussion on this question he said that if the team had not been able to answer it directly (and in this discussion he had included himself with the team) it was because a general answer was not possible. Each individual casting

* When discussing tolerances, they should surely be stated as so many thousandths of an inch per inch or other comparative data quoted—EDITOR.

Foundry "Brains Trust"

had to be taken on its merits and a comparison obtained between the accuracy normally obtainable by conventional methods, that obtainable by shell moulding and that required in the finished component. It was quite likely for many castings to show appreciable savings on balance, but in many other cases it seemed equally doubtful.

Vote of Thanks

MR. NICHOLLS proposed a vote of thanks to the team in which he commented on the excellent manner in which the questions on a wide variety of subjects had been answered and thanked Mr. Forrest in particular for the very able way in which he had served as "question master," by tradition an office usually held by Mr. Neath who was unfortunately unable to be present.

MR. COLLINSON seconded the vote of thanks, and MR. KERSHAW responded on behalf of the team.

New Catalogues

Mechanical Handling Equipment. A surprisingly large field is covered by a folder recently issued by J. Collis and Sons, Limited, Regent Square, Gray's Inn Road, London, W.C.1. Belt, gravity- and power-roller, mobile, inclined, slat and a modern design of chain and pan vertical conveyors; trucks and stackers are all detailed and illustrated. The folder is available to readers on writing to Regent Square.

Furnaces for "Yellow" Metal. Sklenar Furnaces, Limited, Colchester Estate, Cardiff, have presented, in the form of a four-page leaflet, details of a new furnace for use in the brass die-casting foundry. It is made in two sizes, 200 and 600 lb. capacity, and is, of course, of the bale-out type, but of a design which only exposes a minimum of metal surface. The plant is oil-fired (gas can also be used), and the charging arrangements allow of continuous casting. The furnace shows many interesting features. The leaflet is available to those who write to the Cardiff address.

Coated Abrasives. Amongst life's little surprises was the receipt of List Price Catalogue No. 1 from the Norton Grinding Wheel Company, Limited, Welwyn Garden City, Herts, for it had never occurred to the reviewer that there could be so many varieties and grades of such things as emery and "sand" paper. From this catalogue it was learnt that there are four different types of abrasives which are made to adhere to five different backings—paper, cloth, paper combination, fibre combination and fibre. These materials are shown to be available as standard sheets, rolls, belts and discs. The *rôle* of this catalogue is to expand all these to indicate appropriateness, size, availability and price. Patternmakers will find this publication of major interest, but for all those interested in metal finishing it has quite a wide appeal. It is available to readers on writing to Welwyn Garden City.

AN ORDER to make, deliver, and erect high- and low-voltage switchgear worth £60,000 has been awarded to the Brush Electrical Engineering Company, Limited, Loughborough, by the Government of Saurashtra, India. The equipment is to be used for the electrification of towns in the State, and the contract was won despite a lower German tender.

Moulding-pit Accident

Previous Judgment Stands

Whether the sand surface of a foundry was a "floor" within the meaning of the Factories Act was the subject of an appeal by Metropolitan-Vickers Electrical Company, Limited, St. Paul's Churchyard, London, E.C., in the Court of Appeal last week. The company appealed against a judgment of Mr. Justice Stable at Manchester Assizes on May 5, 1953, given in favour of John Alfred Deakin Harrison, who had sued for damages for injury suffered when he fell into a pit at his employers' foundry at Trafford Park, Manchester, on November 27, 1951. Harrison, with another man, was carrying a ladle of molten metal at the time, and suffered burns on his left arm and body.

In awarding Harrison £56 damages and costs (half the total assessed), Mr. Justice Stable had apportioned the responsibility for the accident equally between him and his employers. The company appealed against the judge's finding that they were in breach of statutory duty under Section 25 (3) of the Factories Act, which required that "openings in the floor should be securely fenced except in so far as the nature of the work made it impracticable." It was contended that the pit was not an "opening in the floor" as the sand in which it was dug was not a floor within the meaning of the Act. Harrison appealed against the judge's finding that he was guilty of contributory negligence.

In his judgment, Lord Justice Singleton said it had been contended that the steel-flagged gangways in the factory constituted the floor for the purpose of Section 25. His lordship found it difficult, if not impossible, to say that by constructing gangways the company took away the character of the ground level and so made what was normally considered a floor something other than a floor.

In his view the sand was a floor for the purpose of Section 25 of the Act. He thought the judge was right in holding the employers to be in breach of the section and responsible for damages. His lordship said it was not disputed that it would have been practicable to fence the space dug in the sand. He decided that a claim based on Section 26 of the Act, under which the employers should provide a safe means of access to the place of work, could not succeed.

Fences for Permanent Pits

The other claim was on the ground of negligence, because the pit was adjacent to the gangway and the employers had not taken reasonable care for the safety of the workmen. The judge had held negligence was not proved. Lord Justice Singleton said there was a departure from the ordinary foundry practice in this case. Normally temporary holes for castings were not fenced, but permanent holes were. Temporary holes were not usually right up to the edge of the gangway, but were some distance away. A man stepping backwards would put his foot on the sand and would know he was off the gangway. In this case there was no rail against the hole, which was right up to the gangway. This was not usual. His lordship said the court ought to accept the judge's finding that there was no negligence by the employers, but he was not satisfied he would, himself, have reached the same conclusion.

Lord Justice Singleton also said he did not think he would have found Mr. Harrison guilty of contributory negligence, but he regarded this as primarily a matter for the trial judge. His lordship said he thought that both appeals should be dismissed, with costs.

Lords Justices Jenkins and Hodson agreed, and the appeals were dismissed. Leave for the employers to appeal to the House of Lords was refused.

Rational Foundry Management*

By F. Buckley, B.Sc., F.I.M.

(*Continued from page* 69)

Core Production

It was obvious that a rapid increase in core production at the E.E.C. foundry must of necessity accompany the expansion in moulding operations. For small cores, production was increased with relative ease by the extension of accepted practices, *i.e.*, the further adoption of vertical continuous drying stoves and core benches fed from overhead positions delivering cores to a track system leading to the stoves. Larger cores presented a major problem but here again, production was broken down into: (*a*) Corebox preparation; (*b*) provision of core reinforcement; (*c*) ramming; (*d*) rolling-over; (*e*) blacking and finishing; and (*f*) assembly into sets. A certain amount of unskilled labour can be utilized in the preparation of the corebox and at the roll-over stages, but in order to develop the necessary speed of production and to employ impeller rammers successfully, the following steps were adopted:

(1) The over-"ironing" and over-"gridding" of cores was avoided. A minimum number of irons were used which could be recovered after the Hydroblasting operations and returned for further production purposes.

(2) The somewhat uneconomical method of completely ramming cores with sand was adopted, which obviated difficulties in the supply of ashes, coke, etc., for packing the centres of cores. Impeller rammers were adapted and used quite successfully for ramming purposes and a roll-over machine of 10,000-lb. capacity capable of taking a box size 7 by 5 ft. was incorporated into the system (Figs. 20 and 21). In addition to advantages in production, the use of the roll-over machines resulted in cores of more accurate dimensions, and considerable time was saved in coring-up operations. Rubbing of cores, which previously consumed a large percentage of the moulder's time at the coring-up stage, was reduced to minor proportions.

MOULDING SAND

While it was relatively easy to standardize on a unit core-sand (which contained a percentage of recovered sand from the Hydroblast plant) the standardization of a unit moulding sand that would satisfy the requirements of a range of castings differing widely in size and weight was not so simple. Requirements for this sand were abnormally stringent. It was desired to avoid the use of separate sands for facing and backing purposes; it was also desired to impeller-ram direct on to the pattern without preliminary facing, and to dump the sand directly into the box in the case of the moulds produced by jolting methods. In addition, there was a desire to take "liberties" in drying without the risk of scabs and allied troubles, since quick drying or skin drying was essential to obtain a quick turn-round of boxes. For these reasons, there was successfully developed a synthetic sand with an appreciable pitch content, and after using this for several years it can be pronounced as highly successful. The management carried out the original experiments in this country on the use of pelleted pitch and found it invaluable in preventing scabs and buckles, and they were able to cast moulds successfully which had been stoved only for a fraction of the time formerly required. This statement requires the covering proviso that it was found necessary to close such moulds immediately and cast them the same day.

*Paper presented to the Scottish branch of the Institute of British Foundrymen, Mr. John Cameron, Jnr., presiding.

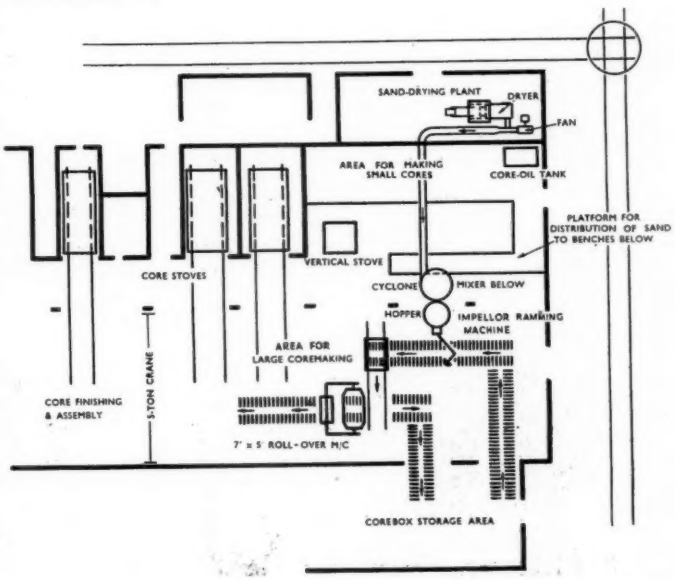


FIG. 20.—*Layout of the core-shop to expand facilities and take in impeller ramming.*

Rational Foundry Management

Cupola Operation

In view of the many excellent papers on cupola practice, it is not proposed to comment on the charges used except to say that the management standardized on one pig-iron for all purposes, the remaining raw materials consisting of cast-iron scrap and steel scrap. The range of mechanical properties required in the castings varies from 12 to 23 tons per sq. in. The cupolas, which previously were widely separated, were replaced by three modern furnaces equipped with mechanical charging of the drop-bottom-bucket type, the latter being loaded on an electrically-propelled scale-car.

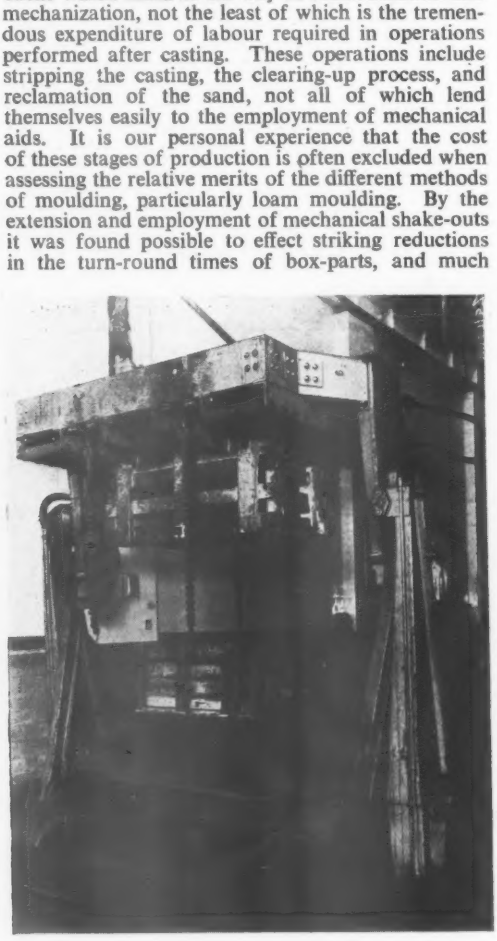
Knock-out

Pit and floor moulding, which still find so much favour in jobbing foundries, have very serious drawbacks which stand in the way of rationalization and mechanization, not the least of which is the tremendous expenditure of labour required in operations performed after casting. These operations include stripping the casting, the clearing-up process, and reclamation of the sand, not all of which lend themselves easily to the employment of mechanical aids. It is our personal experience that the cost of these stages of production is often excluded when assessing the relative merits of the different methods of moulding, particularly loam moulding. By the extension and employment of mechanical shake-outs it was found possible to effect striking reductions in the turn-round times of box-parts, and much more effective utilization of floor space resulted. The knock-out adopted was a double-deck type, with a deck area of 7 ft. 6 in. by 16 ft., and a total capacity of 34 tons (Fig. 22). Difficulties were experienced in adapting this type of equipment to an existing sand plant, particularly since it was necessary to erect it above ground, and trouble due to spillage ensued. Knock-outs of this type are far better installed as an integral part of the original sand-handling system. In spite of this, however, they have proved invaluable in the foundry described, and it would have been quite impossible to maintain output without them.

One point that should be emphasized is that about 95 per cent. of the moulding boxes commonly used in jobbing foundries would disintegrate within a week if they were handled by large shake-outs, and the policy of designing moulding boxes as part of the general reorganization was seen to be justified. As previously mentioned, these are of a lightweight fabricated type and there is no doubt that they are by far the most suitable for the rapid production of heavy castings (Fig. 23). The combined effect of the accelerated knocking-out process, coupled with the quicker turnover in the foundry in moulding, drying and coring operations, has resulted in a reduction of box storage space to a fraction of that previously found necessary for an output less than half that before mechanization.

Cleaning and Fettling

The lighter castings are cleaned by a Wheelabrator plant, and are fed by roller track to a line of finishers. Heavy castings are de-cored by a 2-gun Hydroblast installation, followed by pneumatic chipping and grinding. The latter operation is carried out in a new building built to provide the best



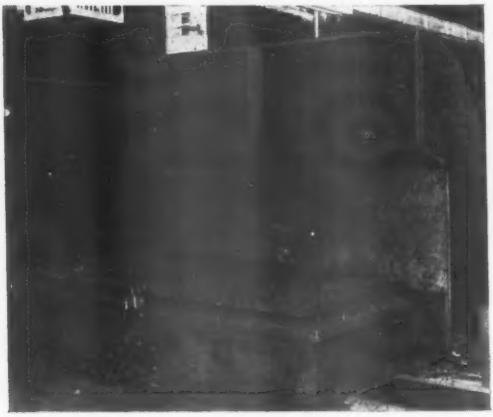


FIG. 21 (*left*).—*One of the roll-over machines of 10,000-lb. capacity for coremaking; they take a box size 7 by 5 ft., and* FIG. 22.—*Double-deck type of knock-out adopted, of total load-carrying capacity of 34 tons.*

available working conditions from the point of view of ventilation (Fig. 24).

The Hydroblast unit is of particular interest because it incorporates a filtration unit to recover the water, the only supply available to the firm being from the town mains. The filtration unit (Fig. 25) deals with the liquid discarded from the classifiers after the larger-size sand grains have been removed. The water, still containing silt, is given a controlled addition of ferric chloride, which acts as a flocculating agent. This is then passed through a sludge blanket in the vertical tanks and finally through a pressure filter. The sludge in the main tanks is run off daily, while the pressure filter is cleaned by back jets. In this manner make-up water costs for the plant are kept to a minimum.

Production Planning and Progress

The production of sound castings in a given time and in a given sequence in the jobbing foundry presents major problems in production planning. This is particularly true when the foundry is a feeder department to a main works employed in the construction of heavy engineering machines, such as prime movers of the steam turbine type. In this case, the criterion of success of any one department is measured only as a function of the whole works. For machines which require months to complete, it is only by the careful matching up of individual components to a rigid time schedule that success is achieved. For relatively small foundry outputs, say below 40 tons, *ad hoc* methods can be used, and these are dependent to a large extent on the individual capabilities of the foundry staff, memory playing a large part in the successful performance of such a system.

However, with outputs considerably in excess of this, a comprehensive system is essential, and it is in this respect that the main benefits of rationalization are felt. The task of tracing individual castings through the various stages of a jobbing foundry with outputs in excess of 100 tons per week, is one of some difficulty, and it was here that the maximum advantage was gained from the mechanization schemes introduced. It was possible to allocate all castings at the order stage to one of the various sections previously outlined in this Paper, and since it was possible to standardize on a given number of moulding boxes in each section from the highest to the lowest, it was possible also to determine fairly

FIG. 23.—(*right*).—*Examples of lightweight, fabricated box-parts generally employed in the foundry, and* FIG. 24.—*New buildings in which is carried on the pneumatic chipping and grinding of heavy castings.*

Rational Foundry Management

accurately the weekly or monthly capacity of each section in terms of moulding-box load. In this manner, production could be planned in advance for months ahead, and—what had not previously been possible—castings could be provided in the correct sequence in accordance with the demands of the main factory.

This system of planning in advance was of course built into an overall progress system which defined the passage of the castings through the various stages of production from the patternshop and foundry departments to the final fettling operations.

Patternshop and Design Liaison

Little would have been accomplished without the establishment of effective liaison both with the patternshop and design departments. This was accomplished by promoting suitable patternshop personnel, after prolonged and extensive foundry training. The construction of patterns strictly in accordance with the production demands of the foundry was attained and, in many cases, features of design which either affected the quality of castings, or interfered with production requirements, were eliminated or modified without sacrifice of service duties.

Conclusions and Comments

1. The installation of expensive machinery and equipment in jobbing foundries is not in itself any guarantee of increased productivity, and unless it is accompanied by a vigorous, and in some cases, a revolutionary change of attitude on the part of the foundry executives, it can be a waste of money.

2. It is impossible to attain the maximum potential of a machine without facing the additional expense necessitated by the provision of efficient auxiliaries such as moulding boxes, and so on.

3. Pit and floor moulding in sand or loam allow little room for manoeuvre in relation to the development of new methods and efficient utilization of machines. It is only when jobs for these methods of production are converted to box moulding that striking reductions in manufacturing times are achieved.

FIG. 25.—*Filtration unit for recovering the water and sand from the Hydroblast plant.*

Comparisons with other foundries, particularly with those indicated in the Grey Ironfounders' Productivity Team Report, have not been made, owing to the difficulty of formulating a true basis of comparison. Similarly, tonnage outputs bear little relationship as a yardstick of achievement when the type of casting varies between 8-ton flywheels and delicate supercharger castings, perhaps 1 cwt. in weight, both of which require an equivalent expenditure of labour. It is believed, however, that the methods adopted give a quicker turnover of the larger type castings than any witnessed in this country or abroad.

Any success achieved has been to a large extent due to a pursuit of the unconventional, and it is suggested that this tendency is more than ever necessary both at the present time and in the future, particularly when the developments in the welded and fabrication fields are studied.

Finally, in addition to the production advantages which have been indicated, the working conditions throughout the whole foundry have been appreciably bettered. Taking one further example in addition to those previously mentioned, it has been found possible to construct the bulk of the foundry floor of concrete. Apart from the actual moulding pits, the percentage left unpaved is now less than 2 per cent. This is in the Author's opinion the final criterion of the success of any scheme of this type. It is not enough to produce two tons of castings where one was produced previously: the two tons must be produced under conditions which leave no room for the stigma of dirt, disorder and untidiness from which used to be associated with the foundry industry.

J. Hobkirk's Board Changes

Following the death of Mr. J. T. Hobkirk who had been chairman of this company since its formation, the directors have now decided upon the reconstruction of the Board, Mr. W. T. Hobkirk becoming the new chairman with his son, Mr. J. T. W. Hobkirk as vice-chairman. In this way the essential family ties with the company have been maintained and there will be no change in the company's policy either in relation to its customers or employees. Mr. W. T. Hobkirk, who was managing director since the company was formed is succeeded in that position by Mr. F. C. Baker, formerly works director. Mr. Baker has been associated with the firm since 1936.

Mr. W. T. Hobkirk also relinquished his appointment as company secretary to Mr. R. H. Mathews, so as to be free to give more time to his national commitments with the trade associations. Mr. Hobkirk is vice-chairman of the South of England Ironfounders Association, a Council member of the Association of Bronze & Brassfounders and a member of the Ironfounders National Technical Committee.

THE 38TH (1954) ANNUAL EXHIBITION of the Physical Society will be held at the Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7, from Thursday, April 8 to Tuesday, April 13. The exhibition will be wholly located in the Physics and Chemistry Department of the College.

Impregnation of Metal Castings

Survey of Available Methods and Materials

In order to secure pressure tightness in a casting, the use of a sealant is sometimes justified. If the casting is structurally sound, however, such a practice should not be used. The sealing method should, moreover, only be considered in the case of castings designed to hold gases or liquids under pressure, and then only when it is necessary to compensate for unfavourable design or limitations in casting techniques. Where the treatment is properly given, impregnation undoubtedly saves costly rejections and increases production capacity.

The use of a sealant will always be regarded by the foundryman and engineer with some suspicion. Nevertheless, it was a time-honoured practice to leave an iron casting in the open long enough to become thoroughly rusted and in so doing cure minor troubles with porosity. Treatment with sal-ammoniac and iron filings has also been tried on occasions.

Materials

Sodium-silicate type fillers, with or without metal flours.—These are fillers and commonly referred to as colloidal, but the term semi-colloidal probably would be a more accurate description, since they are usually 500-mesh iron and copper powders, usually requiring agitation in the filling process. They do not exhibit the Brownian movement of true colloids. Metal-powder fillers also bring the risk that particles will filter out of solution and bridge microscopic pores, later to be ruptured under wear and thus unseal a capillary duct. Sodium silicate itself shrinks on baking, is reactive with some metals, and somewhat abrasive, so that sub-surface residue may injure bearing surfaces when finish-polishing is done after machining. However, it has exceptional di-electric properties and withstands unusually high temperatures and pressures. However, there is a strong trend toward adoption of resin-styrene compounds described in what follows.

Linseed or tung oils.—These, like sodium silicate and its compounds, are baked after impregnation is complete. They are subject to gradual oxidation that may extend to complete deterioration in time.

Resin and resin/oil combinations.—Styrene with linseed oil or dehydrated castor oil, and certain Bakelite resins are examples of these combinations. These are thermosetting compounds, varied in their properties and in the incidence of volatile and resin constituents, resistant to temperature changes, solvents and chemicals.

New compounds.—These are air-setting and require no baking. Many, but not all, of this group and the resin and resin/oil group are described as solids in true solution which suffer no shrinkage during drying or curing.

In general it may be said that the best impregnants are those of low viscosity, preferably of low volatile content, which dry or cure to solid infusible materials with little or no loss of volume. They should withstand temperatures of 150 deg. C. and have no effect on machinability of the impregnated part.

Methods

There are five methods by which impregnation is or has been practised:—

(1) By immersion of the casting in the impregnant in a pressure-tight vessel to which pressure is applied. This is the oldest method. The obvious flaw is that the impregnant, under pressure, tends to compress air in microscopic holes or capillary passages and after decompression the air will force the medium out of some of the pores. To that extent the purpose of impregnation is defeated. Even though small bridges of solid impregnant cover other pores, they are liable to rupture in service.

(2) Using the internal-pressure method by which sizeable castings are sealed off except for a single port. The impregnant is then introduced and pressure applied at this entrance port. The pores and capillaries are thus filled from the inside progressing outwards. This method is expensive because of the preliminary sealing involved and suffers the same post-treatment hazards as the first method.

(3) The use of external pressure and batch immersion suffers the same disadvantages as the first method but treats more parts at less cost per unit.

(4) Vacuum impregnation by batch immersion, followed by pressure application, can be adopted. This method is applicable equally to large castings, when equipment of practical size will permit only one at a time to be handled in trays or baskets.

(5) Vacuum alone is used in a process by which all ports are sealed, with a vacuum connection at one port. The casting is submerged in the sealing compound and external vacuum tends to pull the sealant through the walls from outside to inside.

The first method is not well favoured; of the other three methods (2) and (4) are to be preferred. It may be said that the first three methods merely seal of the openings, creating the risk that service wear, corrosion, or (with some impregnants) electrolysis, may expose new defects.

Applications

The production of castings that must be pressure-tight or leakproof is often rather difficult as a result of the design chosen. Impregnation with a suitable sealing agent will usually salvage castings that do not pass the initial pressure test. The type of impregnant chosen from those listed depends upon the substance that the casting is required to hold. When treating one casting at a time by the sodium silicate method, all openings except one are closed and the casting is filled with sealing fluid. Then a fitting is attached to the remaining opening and air pressure of at least 10 lb. per sq. in.

Impregnation of Metal Castings

is applied. The operation is facilitated by heating both the casting and the impregnant to 65-to 95 deg. C. The pressure and temperature are maintained until seepage occurs or the leak is stopped.

In the batch process, the castings may be immersed in a suitable tank containing the impregnant maintained at the same temperature as before. A pressure of from 500 to 100 lb. per sq. in. may be used to assist the capillary action to draw the sealing fluid into the pores of the casting. As a rule, an immersion time of 2 to 6 hours is sufficient. In both processes, the sodium silicate is mixed with water in proportions varying from 1 to 5 and 4 to 1 ratios. The concentration depends upon the requirements of the particular casting. After satisfactory impregnation, the casting is allowed to drain, is then washed thoroughly in hot water, and then heated to 100 to 150 deg. C. for from one to two hours.

Foundry Methods of Amelioration

Impregnation must not be regarded as a means of salvaging structurally faulty castings. The process in fact is only effective when the leaks are small. In general, good foundry practice involves such measures as the following to correct porosity: (1) Employ good moulding and metal handling procedures; (2) flux adequately; (3) improve the permeability of the mould; or (4) if necessary alter the gating, riser or chilling procedures.

In particular cases, especially when a high degree of pressure tightness in the casting is required, additional core prints are desirable to help in removing core gases. Core-prints should be large enough to permit easy removal of the core strengthening wires and chills. If core prints are located in a highly-stressed section, a bead around the hole to compensate for loss in section area is recommended. Openings in casting walls made by core prints can be filled, if necessary, with a threaded plug. Chaplets for supporting cores are sometimes necessary, but should be avoided wherever possible on castings required to be pressure tight, since leakage often occurs at the place where such devices have been employed.

Contracts Open

The dates given are the latest on which tenders will be accepted. The addresses are those from which forms of tender may be obtained.

BATH, February 9—Supply of galvanized steel tubing, steel columns for street lighting, spun-iron pipes and special castings, valves and hydrants, and cast-iron surface boxes, for the City Council. The City and Waterworks Engineer, Guildhall, Bath.

BOLTON, February 6—Supply of cast-iron gully grates and frames, gullies, manhole covers, and step irons for the year ending March 31, 1955, for the Borough Council. The Borough Engineer and Surveyor, Town Hall, Bolton.

CANNOCK (STAFFS), February 9—Supply of cast-iron manhole and gully covers, frames, etc., for the year commencing April 1, 1954, for the Urban District Council. Mr. C. F. Poole, cleansing and transport superintendent, Council Offices, Church Street, Cannock.

HEREFORD, February 8—Supply of iron castings for the year ending March 31, 1955, for the City Council. Mr. F. Margerison, city surveyor, Town Hall, Hereford.

Publications Received

Nimonic Alloys—Annealing and Pickling. Issued by Henry Wiggin & Company, Limited, Wiggin Street, Birmingham, 16.

This new publication gives up-to-date information on the annealing and pickling of two alloys of the Nimonic Series which are most widely used in sheet form, Nimonic 75, and its modified form, Nimonic F, replacing earlier fabricating instructions. This includes notes on temperatures for annealing and furnace atmospheres, together with formulæ of acid pickles and alkaline liquors, and details of salt bath descaling. Copies may be obtained from the company at the address quoted.

Elements of Foundry Costing—Part II Metal and Melting Cost, Part III Moulding and Coremaking, by H. P. Court and W. E. Harrison. Published by the Council of Ironfoundry Associations, 14, Pall Mall, London, S.W.1.

The first of this series of ten booklets was of a general nature, but these new ones are much more "meaty" and put forward concrete schemes for adoption by ironfounders.

In a nutshell, Part II recommends the use of controlled melting practice, with weighing at several points in the sequence of operation. The scheme is based on ascertaining the cost of metal at the spout, and "shop scrap" is valued at ingredient cost—both the latter being controversial matters. The keeping of very full records is advocated—even to the extent of weighing the metal poured. The "grossing" method (that of computing original stocks, adding receipts and deducting final stocks) is mentioned as a poor alternative to proper measurement of consumption of materials, but it could surely be incorporated as a check on periodical figures obtained. Not all ironfounders will agree with the methods enunciated, and the smaller establishments may find even the "simplified" system too clumsy, yet it is essential that each should extract what can be best applied to their current production, for accurate costing is more necessary to-day than ever before in the history of the industry.

Similar remarks apply to Part III of the series, on moulding and coremaking, but here there is less that is controversial. Labour costs are the chief values to be computed, and for these the allocation into direct and indirect charges is logically explained, as is the theoretical desirability of separation of departmental overheads. Coremaking costs are, of course, separated, yet for the smaller concerns grouping of these on the basis of direct labour outlay is suggested—though the building-up of standard costs is advocated for the larger foundries. Methods for calculation of overheads are carefully explained, and final paragraphs briefly survey estimating and time- and motion-study operations.

A possible way of improving both studies would, the reviewer suggests, be the inclusion of half-a-dozen or so method summaries applied to foundries of different size and complexity. The majority of large foundries have already instituted costing systems which by the test of time have been well proved; for the rest, careful study and application of the methods where they fit is advocated.

HIGH DUTY ALLOYS, LIMITED, a member of the Hawker Siddeley group, has formed a new subsidiary, High Duty Alloys (Canada), Limited. Mr. Crawford Gordon, Junr., president of A. V. Roe, Canada, also a member of the group, has been appointed president of the new company.

Closing of Newmains Foundry

A deputation from Newmains and Shotts area of Lanarkshire on January 15 met the Minister of State, the Earl of Home, and Brig. A. R. W. Low, Parliamentary Secretary to the Ministry of Supply, in Edinburgh, to appeal for steps to be taken to provide employment for the men who will be unemployed when Coltness Foundry at Newmains closes down. The foundry is owned by G. & J. Weir, Limited, Glasgow. The deputation included Miss Margaret Herbison, M.P., Mr. Alex Anderson, M.P., and Mr. Patrick Maitland, M.P., and representatives of various trades and associations in the district.

Miss Herbison gave figures of the employment at the foundry and the numbers which she understood were to become redundant. The foundry has employed about 600 men and emp'oyment for only 100 will remain. The deputation stressed the serious loss of skill which this would mean, and appealed to the Government to give assistance either in bringing more foundrywork to Coltness, or in persuading other industries to come to Newmains.

Lord Home said that in the first place he had to make it clear that the Government had no powers to direct any private firm to go to any particular site. The Ministry of Labour had given him figures which suggested that in a couple of years there would be a shortage of labour within six miles of Newmains, and that the immediate problem was one of finding some other source of employment.

Miss Herbison expressed considerable doubt as to the statement that there wou'd be a shortage of labour in that district in two years. Lord Home, summing up, said it seemed to him that the prob'em was to persuade some other industry to come to Newmains. He undertook that a Government Department would make inquiries into certain possibilities which were discussed and see what could be done. Developments in local industries were being explored, he pointed out.

Obituary

MR. CHARLES PARKER, who died recently, was managing director of the Coronet Tool Company, of Mansfield Road, Derby. He established the firm in 1945 after he had designed the Coronet lathe. Mr. Parker was formerly supervisor of the tool-room at Rolls-Royce & Company, Limited.

The death is announced of MR. E. J. FOX, at the age of 79. He was for 25 years managing director of Stanton Ironworks Company, Limited, where, in collaboration with Mr. P. H. Wilson he pioneered the manufacture of centrifugally-cast pipes. Before the war, he was frequently the chief guest at dinners organized by the branches of the Institute of British Foundrymen, where his wit and wisdom alike were much appreciated. He so valued the work of the Institute that he presented a gold medal to be awarded annually to those who have made outstanding contributions to its progress and welfare. His early days were spent with the B.T.H., and later he was London-office manager of Stewarts and Lloyds, Limited. As managing director of the Stanton Company, he sponsored many successful innovations which contributed to the prosperity of the organization. When the company was amalgamated with Stewarts and Lloyds, he served on the Board of that company and was also a director of Crompton Parkinson, Limited. In 1935, he joined the Board of Davy & United Engineering Company, Limited, retiring in 1944. Mr. Fox's name is perpetuated for all time among foundrymen by the medal which bears it.

Colombo Plan Advisers Appointed

The Government of India last year set up a Committee to advise on methods of obtaining increased production from industry. To assist this Committee in its investigations, the Indian Government asked H.M. Government to provide under the Colombo Plan technical co-operation scheme two British experts—one in foundry operation and one in the machine-tool industry.

The foundry expert is required to survey the foundry industry in India, to locate "bottlenecks" and suggest measures to cure them. The expert on machine-tool production will make recommendations for rationalized production. H.M. Government agreed to assist the committee (known as the Mulgaokar Committee after its chairman, who is an Indian engineer employed by Tata's) and have obtained the services of the two experts—Mr. A. B. Lloyd, a member of the Institute of British Foundrymen, and Mr. J. D. Scarfe, a consultant production engineer. Mr. Lloyd arrived in Delhi on January 3 and Mr. Scarfe on January 5. They will spend three months in India, visiting foundries and machine-tool factories all over the country.

Mr. Andrew Bolton Lloyd was educated at Charterhouse and Trinity College, Cambridge, where he obtained a B.A. degree in Mechanical Science. In 1936, he joined the firm of F. H. Lloyd & Company, of Wednesbury, Staffs, the largest producers of steel castings in the U.K. He served in the second world war as a lieutenant in the Royal Army Ordnance Corps. On release he rejoined his firm and in 1944 was appointed production director. Since 1949, he has been sales director. Mr. Lloyd is also an associate member of the Institution of Production Engineers, and a member of the Iron and Steel Institute. Mr. Joseph Scarfe is a member of the Institute of Mechanical Engineers and a member of the Institution of Production Engineers. He was formerly joint managing director of John Lund, Limited, one of the leading firms in the U.K. machine-tool industry and is now practising as an adviser of reconstruction and production engineering.

Board Changes

SENTINEL (SHREWSBURY), LIMITED—Mr. W. Laurie has retired from the board.

AUDLEY ENGINEERING COMPANY, LIMITED—Mr. W. E. Parker has retired from the board.

G. D. PETERS & COMPANY, LIMITED—Mr. Robert Needham has ceased to be a joint managing director.

CROFTS ENGINEERS (HOLDINGS), LIMITED—Mr. M. T. J. Goff and Mr. H. Matthews have been elected directors.

ALUMINIUM, LIMITED—Mr. H. H. Richardson and Mr. Dana T. Bartholomew have been appointed directors and vice-presidents.

LANCASHIRE DYNAMO ELECTRONIC PRODUCTS, LIMITED—Mr. R. J. F. Howard, chief engineer, and Mr. S. Burr, works manager, have joined the Board.

BIRMINGHAM ALUMINIUM CASTING (1903) COMPANY, LIMITED—Mr. H. Peters, works director, and Mr. W. J. Price, sales director, have been elected to the Board.

EXPANDED METAL COMPANY, LIMITED—Mr. Edgar J. A. Flight and Mr. Harry P. Salmon have been elected directors. Mr. Frank Banfield has been elected a director and appointed general manager.

Personal

MR. D. V. HOUSE and MR. E. W. RODWELL have been appointed to the Board of McKechnie Brothers.

DR. HERBERT SCHOLFIELD, former principal of Loughborough Engineering College, opened the first section of the College of Further Education, Beeston.

MR. ALLAN SYKES, assistant secretary of the Cutlers' Company, Sheffield, has been appointed secretary in succession to Mr. J. H. Whitham, who has retired.

MR. W. T. KITCHING, M.I.MECH.E., is now associated with Campbell, Gifford & Morton Limited, who are constructing a continuous casting plant at a Sheffield steelworks.

MR. R. B. WILLIAMS has been appointed secretary of Jury Holloware, Limited, following the death of Mr. John Davies Evans. Mr. Evans was also on the Board of the company but no new director has yet been appointed.

MR. S. F. WISE, who recently resigned his appointment as purchasing and material control manager, with Baker, Perkins, Limited, has now joined M. Clayton & Son, Limited, brassfounders, brass finishers and general engineers, Bradford, Yorkshire, as director and secretary.

MR. J. H. R. NIXON, who is well known in engineering and education circles of the East Midlands, has been appointed chairman of the East Midlands branch of the Institution of Mechanical Engineers. Mr. Nixon is technical director of the Brush Electrical Engineering Company, Limited, Loughborough.

MR. F. H. HOULT AND MR. R. J. PALMER have been appointed local directors of Newton Chambers & Company, Limited, Chapeltown, Sheffield. Mr. Hoult is general manager of the light castings foundry and engineering department and Mr. Palmer is general manager of the firm's excavator works.

MR. E. E. BAKER, export sales director, has been appointed to the Board of Raleigh Industries, Limited. MR. B. L. C. DODSWORTH, company secretary, has been elected to the Boards of all Raleigh subsidiary companies. MR. D. S. ROBINSON has been elected to the Board of Sturmey-Archer Gears, Limited.

MR. JOHN LINDSAY, chief estimator with Barr Thomson & Company, Limited, Netherton Iron Works, Kilmarnock, has completed 50 years' continuous service with the firm and has been presented with an inscribed silver salver and a long service certificate. Mr. W. Manson, managing director, made the presentation.

MR. F. G. HORTON, a past holder of a Founders' Company Fellowship and a Mond Nickel Fellowship, has joined the staff of Cardiff Foundry & Engineering Company (1947), Limited, as assistant foundry manager. The first award he used for study at the National Foundry College and the second for gaining experience in European foundries.

MR. A. P. WICKENS, chief engineer, Armament Design Establishment, Fort Halstead, Ministry of Supply, and who was previously deputy chief engineer, Fighting Vehicles Research and Development Establishment, will join Vickers-Armstrongs on March 1. He will be manager, industrial tractors, at the Scotswood works. Mr. Wickens becomes a special director of Vickers-Armstrongs from the same date.

MR. JAMES SMITH has retired in his 80th year after 42 years unbroken service as a patternmaker with James Beresford & Son, Limited, pump and railway-fittings manufacturers, of Kitts Green, Birmingham. Mr. James Mason, works manager, who himself has had 48 years service with the company, presented a cheque to Mr. Smith to commemorate his retirement. Cheques were aso presented to four other employees who have retired.

MR. JOHN N. REID, works manager of Torwood Foundry, Larbert, has been appointed to the Board of the firm Jones & Campbell, Limited. Educated at Falkirk and Glasgow University before joining the staff in 1915, he spent some time in the accounts department and took over wages control in 1917. After technical training at Glasgow Royal Technical College, he was appointed first assistant works manager and later works manager. In 1948-49 he was president of Falkirk branch of the Institute of British Foundrymen.

MR. LEONARD H. SHORT has been appointed general export manager of the English Electric Company, Limited. He succeeds Mr. H. S. Aspinall, who retired from this office on December 31 last. Mr. Aspinall will continue as a director of the English Electric Export and Trading Company, on special duties and projects in connection with the company's export affairs. Mr. Short, who is a director of the English Electric Export and Trading Company, Limited, was made deputy general export manager of the English Electric Company, Limited, in 1951, a position which he has held until the present time.

Imports of Ferro-alloys and Calcium Silicide

The Board of Trade have announced that open individual licences will be issued for imports of calcium-silicide and unwrought ferro-chrome, ferro-silicon, ferro-silicon-chrome and silico-manganese which are consigned from and originate in any country other than:—

Albania, Argentina, Bolivia, Bulgaria, Canada, Colombia, Costa Rica, Cuba, Czechoslovakia, Dominican Republic, Ecuador, El Salvador, French Somaliland, Germany (Russian Zone), Guatemala, Haiti; Honduras, Hungary, Japan, Korea, Liberia, Nicaragua, Panama, Persia (Iran), Philippines, Poland, Roumania, Tangier, United States of America, Union of Soviet Socialist Republics, Venezuela.

Applications should be submitted on form ILB/A to the Import Licensing Branch, Board of Trade, 43, Marsham Street, London, S.W.1, and should be accompanied by an undertaking (in the event of an import licence being granted) to furnish to the Ministry of Supply, at monthly intervals, details of the quantity, grade, value and sources of supply of imports of each material effected under the licence.

Other clauses in the announcement deal with interim measures and countries which will be considered separately.

I.B.F. Meeting—date correction: The meeting of the Wales and Monmouth branch of the Institute of British Foundrymen in February will be held on Saturday, February 20, not February 28 as was listed in some of the Institute's own announcements. The meeting will be held at the Newport Technical College, at 6 p.m., and the Paper will be by Mr. D. N. Buttrey on "The Shell-moulding Process."

AN EXHIBITION was opened recently in the Hall of Power of the Royal Scottish Museum, Edinburgh, to mark the anniversary of the birth of James Watt in 1736 and the centenary of the Watt Institute and School of Arts.

News in Brief

RADIOVISOR PARENT, LIMITED, announce that Mr. W. G. Thomas, M.INST.F., has been elected a director.

THE ASSETS of the Foremen and Staff Mutual Benefit Society now amounted to £9,000,000. In the past year there had been nearly 2,000 applications for membership.

CAPE TOWN CITY COUNCIL has awarded the Brush Electrical Engineering Company, Limited, of Loughborough, a contract for two £30,000 kva power transformers.

IMPORTS of iron and steel scrap into the Tees last year increased by over 200 per cent. During the year a total of 302,067 tons was brought in compared with 83,668 tons in 1952.

EMPLOYEES of the firm of Frank Grounds Limited, of Birmingham, celebrated the diamond jubilee of the company early this month at a staff party to which they were entertained by the directors.

ARMSTRONG WHITWORTH (METAL INDUSTRIES), LIMITED in association with Jarrow Metal Industries Limited have issued a four-page leaflet carrying 3-D pictures of a steel casting; a crusher and a printing machine.

HEAD, WRIGHTSON & COMPANY LIMITED, Thornaby-on-Tees, announce the opening of a branch office at 7, The Side, Newcastle-on-Tyne, 1, with Mr. F. C. Wake, recently Regional Controller of the Ministry of Supply, in charge.

FOR THE YEAR AS A WHOLE, exports to North America at £315.6 million, were 14 per cent. more than in 1952. Exports to the United States, £158,8 million were 9 per cent. higher and exports to Canada, £156.8 million, were 21 per cent. higher.

LONG-SERVICE AWARDS in the form of watches and a cigarette case have been presented to the managing director, Mr. John Carter, and eight executives and employees of the Midland Heating and Ventilation Company of Birmingham.

GEORGE COHEN, SONS & COMPANY, LIMITED, of Wood Lane, London, W.12, have created a fleet of fork-lift trucks for hiring out to industry. These are of the Stacatruc make and have a lifting capacity of 2 tons to a height of 12 ft.

RICHARD PLATTS, a 50-year-old furnaceman, of Stanningley, was detained in Bradford Royal Infirmary, last Friday, after his left foot had been crushed by metal falling on it at the engineering works of Crofts (Engineers), Limited, Bradford.

THE SHEEPBRIDGE ENGINEERING LIMITED, held their fifth annual ball recently at the Victoria Hotel, Chesterfield. Representatives from other companies of the Sheepbridge group attended, and it is estimated that 430 people in all participated.

THREE MEN were injured and 25 treated for shock on the night of January 15 after a 112-ft. high hot-blast stove, 22 ft. dia. and weighing 78 tons, was blown over in the gale as it was being erected at Stewart and Lloyds' iron and steel works at Bilston.

THE ANNUAL BALL of the Brush Engineering Company Limited, Loughborough, was held in the Town Hall, Loughborough, and was attended by more than 700 people. Many executives from Brush Group attended, including directors of the main board, and local directors.

THE SECOND ANNUAL DINNER of the M.K.B. Birmingham Works "25 Club" was held in Birmingham recently when watches or clocks were presented to ten employees who have completed 25 years' service with McKechnie Brothers Limited, of Widnes, and Birmingham.

THE *Sunday Times* is co-operating with *Research* in organizing a "Science in Industry Essay Competition," the entries for which have to be forward to *Research* on or before June 30, 1954. Further details are obtainable on application to Butterworths Scientific Publications, 88, Kingsway, London, W.C.2.

THE BRITISH STANDARDS INSTITUTION from 2, Park Street, London, W.1, has issued a draft code of practice (CP/8FE/2) for the installation and maintenance of underfeed stokers for technical comment by industry. Users and manufacturers views should be submitted to the appropriate committee before February 23.

JOHN SMITH (KEIGHLEY), LIMITED, crane makers, were responsible for supplying the main handling equipment at the oil dock at Eastham, near the entrance to the Manchester Ship Canal, which was formally opened on January 19 by Sir Leslie Roberts, chairman and managing director of the Ship Canal Company.

CHAMBERLAIN INDUSTRIES LIMITED, of Staffa Works, Leyton, London, E.10, announce an agreement with Walter P. Hill, Inc., of Detroit, Michigan, U.S.A., design and development engineers making special-purpose machinery, principally for the production and testing of engineering parts made from tube and plate.

THE *Société Française de Metallurgie* have accepted the invitation of the Institute of Metals to hold a joint meeting in London, followed by visits to the provinces. This will take place from April 26 to May 4. The programme includes technical sessions, works visits, excursions, a Government reception and a banquet at Grosvenor House.

THE CLYDE SHIPBUILDING FIRM of Lobnitz, Limited, Renfrew, has won an important dollar contract from Canada in face of stiff American competition. The order—for dredging machinery—is worth about £44,000. The machinery is for a new dredger being built at Victoria, Canada. Propelling machinery for the dredger is being provided by a Lincolnshire firm.

THE SIXTH LIEGE INTERNATIONAL FAIR is to be held from April 24 to May 9 next. The Fair is devoted to mining, metallurgy, and mechanical and electrical engineering. Non-Belgian companies which desire to participate should communicate with the Fair authorities' London agents and office, Mattis Industries, Limited, 4, John Adam Street, London, W.C.2, where Mr. M. Harman can answer enquiries.

THERE WERE SIGNS of an improvement in the foundry trade, said Mr. John Norton, chairman and founder of Norton Industries, Limited, and its four subsidiaries, J. Norton & Son (Metals), Limited, Bradley, Loxdale Engineering Company, Limited, Ettingshall, Priorfields Foundry, Limited, and Bilston Shot & Grit Company, Limited, when he spoke at the firm's dinner on January 16.

CLIFFORD MOTOR COMPONENTS, LIMITED, announce that Mr. Herbert Clark is joining the board of its subsidiary company, Clifford Aero and Auto, Limited, and will take over the position of managing director in March. Mr. H. J. Stretton, the present managing director of Clifford Aero and Auto, Limited, has resigned to take up a post with G. D. Peters, Limited, of Slough, as a director and general manager.

News in Brief

MRS. W. H. HARPER, wife of the managing director, distributed the prizes to apprentices of John Harper and Company, Limited, Willenhall, at the annual prize distribution on January 15. Mr. C. L. Old, principal of Wolverhampton and Staffordshire Technical College, said that compared with 20 or 30 years ago, apprentices had marvellous opportunities.

ABOUT 250 CHILDREN attended the first of two parties held for children of employees of the International Combustion Limited, Derby, at the work's canteen, and no fewer than 550 children attended the second party of Qualcast Limited, of Derby, at the King's Hall, Derby. Among those present at the latter were Mr. V. Jobson, chairman and managing director, J. R. Fleming, assistant managing director, and Mr. H. Clarke, works manager.

THE COUNCIL of the Institution of Production Engineers announces that the Right Hon. The Earl of Halsbury, managing director of the National Research Development Corporation, has accepted the invitation to present the 1954 Sir Alfred Herbert Paper, which will be presented at Olympia, London, at the opening session of a conference sponsored by the Institution running concurrently with the exhibition, July 7 to 14, 1954.

CONDITIONS have been inserted in the leases of plots allocated to factories on the new trading estate at Solihull, near Birmingham, forbidding the use of noisy machinery or equipment. Recently the town's Medical Officer, Dr. I. M. MacLachlan, in a report to the Public Health Committee, stressed the importance of the suppression of noise from machinery which, he said, would be detrimental to the health of nearby residents.

BECAUSE he asserts that goods in transit on the railways are often damaged by rough handling, Mr. A. G. B. Owen, chairman of Rubery Owen & Company, Limited, Darlaston, plans to build up his own transport service for delivering his firm's products. He intends forming a fleet of heavy articulated lorries and setting up a series of warehouses throughout the country which will act as distribution centres. Mr. Owen is confident that the change will be worth while.

JOHN FOWLER & COMPANY (LEEDS), LIMITED, engineers, Leeds, are producing at their factory at Sprotborough, Yorks, alloy castings for a new type of lifeboat-towing tractor recently ordered by the Royal National Lifeboat Institution for use at the various lifeboat stations. The tractor, which can, it is stated, be made watertight in 4 or 5 seconds so that it can be left in the water until low tide, after towing out the boat, can haul a 20-ton lifeboat across the beach for launching.

IN THE WILL of Mr. John Henry Gourley, formerly chairman and managing director of the Wombwell Foundry and Engineering Company, Limited, two bequests of £1,000 each were made to two members of the firm, Mr. Ralph Gelder, managing director since last September, and Mrs. Ethel M. Sokell, assistant secretary. The bequests were "as an acknowledgment of loyal service." Mr. Gelder, has been with the firm for 50 years, and Mrs. Sokell for more than 30 years.

A NEW 10-TON Efco-Héroult arc furnace has been commissioned at the Toledo Works of Andrew Toledo Limited, Sheffield. It will augment existing melting equipment consisting of three "acid" open-hearth furnaces used primarily for the production of carbon and medium-alloy steels. Suppliers of the unit, the Electric Furnace Company, Limited, Weybridge, pioneered the first electric-arc furnace to be installed in this country at the Sheffield works of Edgar Allen and Company Limited, in 1910.

EMPLOYEES of Qualcast Limited, of Derby, received a bonus of 10s. in their pay envelopes recently. This was to commemorate a presentation of long service awards at a social held at the King's Hall, Derby, on January 15. Mr. J. Thorpe of the die-moulding department of the patternshop, received a clock for 20 years' service. The awards were presented by Mr. V. Jobson, who informed the employees that the die casting division last year distributed over 18 million castings.

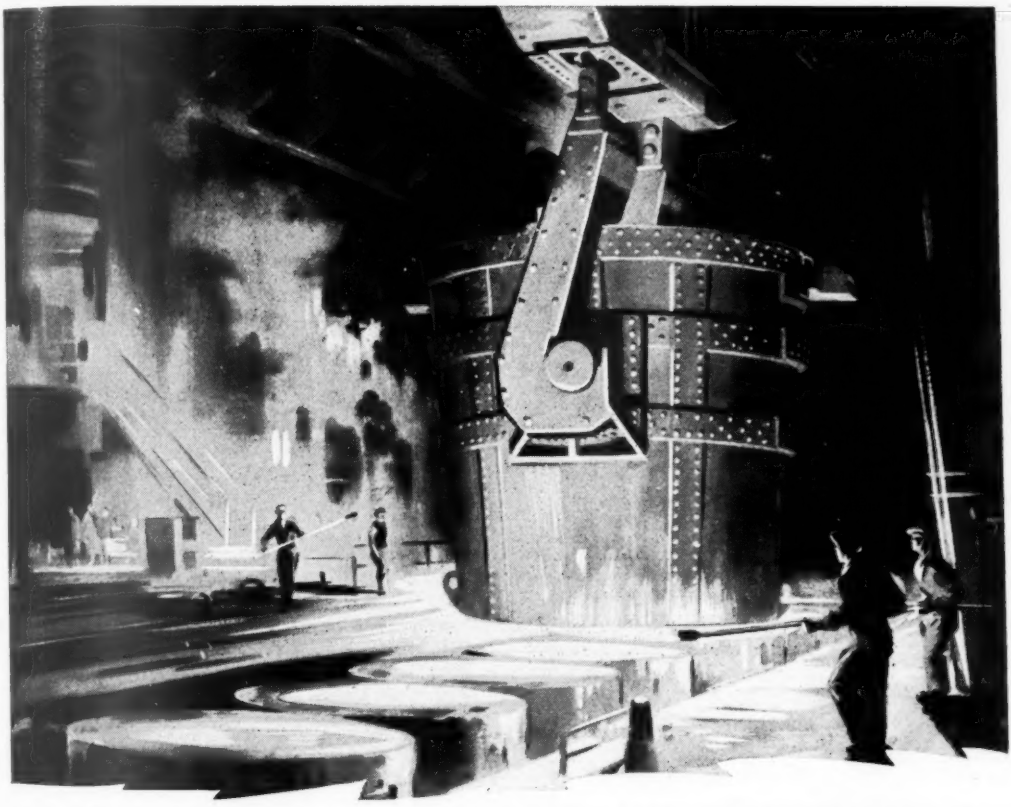
AN EXHIBITION was opened last week by Deritend Precision Castings, Limited, of Droitwich, at the County Hotel, Nottingham, illustrating the technique of casting by the *cire perdu* (lost-wax) process. Although the method was known centuries ago, it was adopted during the war when a means of making jet-aircraft turbine blades quickly was needed. Components can be produced with fine accuracy, and high-grade alloy steels, difficult to machine, may be used. The exhibition precedes a larger one to be arranged in London.

THE SAFETY GOGGLES DIVISION of J. and R. Fleming Limited, of 146 Clerkenwell Road, London, E.C.1, have an untouched photograph of current interest, because of the Iron and Steel Regulations, 1953. It shows a pair of glasses worn by a cupola man, which received during tapping a heavy fragment of hot metal which fractured the Armorglas lens. The latter, although badly cracked, did not break. It would seem that but for the fact that the man was wearing suitable protection he would now be blind in one eye.

AN ARTICLE in *Zinc Bulletin* (*No.* 11), published by the Zinc Development Association, Lincoln House, Turl Street, Oxford, by Mr. R. Fitzmaurice, an authority on building science, describes the design of gutters and pipes for buildings of various sizes, with particular reference to weather conditions in Britain. It constitutes a practical guide to the selection of correct sizes which is of great value in the present housing shortage. The instructions given, if followed, will successfully avoid the serious dangers of dry rot which inevitably arise when designs are faulty in this respect.

WITH THE APPROVAL of the Ministry of Supply, a Birmingham firm, Integra Company, Limited, has entered into a joint production agreement with an American company, Leeds, Northrup Company, Philadelphia, for whom it has been British representative and licensee for some years. The new company will be known as Integra, Leeds & Northrup, Limited. Mr. Jean Rogister, the Belgian Consul in Birmingham, who was manager of Integra, becomes managing director of the concern. The £80,000 investment by the American company is for expanding production facilities and tooling up.

THE OWEN ORGANIZATION has recently published a Film Catalogue which portrays the large number of films that have been produced for member companies of this Group which, with it parent company of Rubery, Owen & Company, Limited, at Darlaston, South Staffs, is composed of nearly 40 engineering firms. In this catalogue are firms illustrating the manufacture of parts for the motor industry, types of agricultural equipment, mechanical-handling appliances, and the story of the B.R.M. racing car. A colour film is at present in production which will present the Owen Organization as a whole, and it is hoped that this will be available during the spring.

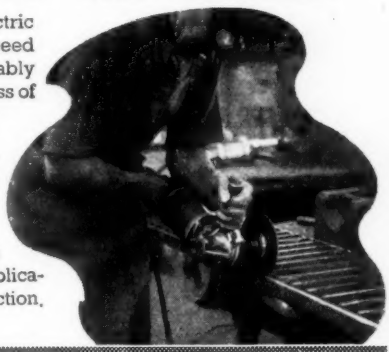


Hicycle **TOOLS IN THE SERVICE OF THE FOUNDRY**

Hicycle tools should not be confused with ordinary 50-cycle electric tools. Operating instead on 200 cycles they develop a motor speed which is sustained under all operating loads. This means measurably more work in a shorter period, and although possessing the toughness of air tools their operating costs are considerably lower. Moreover, Hicycle tools are safe, only 125 volts or 72 volts to earth.

Hicycle is accepted as THE modern production system wherever drilling, reaming, tapping and grinding operations are carried out on any scale. In fact, Hicycle should be investigated wherever there are more than two or three power tools in use.

The Foundry Industry is one of the many fields in which Hicycle has proved its power to increase output and lower costs. Write for publication S.P.354 as a first step to increasing the efficiency of your production.



FOR THE RIGHT APPROACH....
THE RIGHT EQUIPMENT

CALL IN **Consolidated**

CONSOLIDATED PNEUMATIC TOOL CO. LTD. • LONDON & FRASERBURGH

Reg^d. Offices: 232 Dawes Road, London, S.W.6. Offices at Glasgow • Newcastle • Manchester • Birmingham • Leeds • Bridgend Belfast • Dublin • Johannesburg • Bombay • Melbourne • Paris • Rotterdam • Brussels • Milan • and principal cities throughout the world

Raw Material Markets

Iron and Steel

Production of pig-iron from the furnaces in blast is at capacity levels, and the raw material supply position provides adequate tonnages for the maintenance of outputs at recent levels.

Most of the foundries continue to be fairly well employed, but many of them would prefer to see an increase in their forward commitments. The engineering and speciality foundries are the most favourably employed, but to implement the work on hand they are faced with difficulties in the supply of the low- and medium-phosphorus irons and hematite which they utilize. Supplies of both grades barely meet production requirements. The light and jobbing foundries, while employed on a better scale than for some time past, are in need of increased business to keep all plant fully occupied. The position is better in some areas than in others. Foundries which provide castings for household equipment are employed on a much better scale. The supply of high-phosphorus pig-iron is sufficient to meet their needs.

Deliveries of foundry coke are generally satisfactory and most foundries have adequate supplies of scrap, ganister, limestone, and firebricks.

There is little change to report in the trading conditions at the re-rolling mills, which continue to rely on day-to-day business for small bars, light sections, and strip. Home consumers continue to specify a fair tonnage to cover orders on hand and to replenish stocks as they become absorbed, and the chief drawback is the shortage of orders from oversea buyers. In the absence of improved export business the re-rollers are unlikely to show any appreciable change on their present position.

The expected improvement in business for heavy sections and joists has so far not materialized to the extent that was hoped for, but more inquiries are being received, which is taken as a good omen. The high rate of production continues to be maintained, with the result that further inroads are being made into makers' order-books. The requirements of sheets and plates are still far in excess of present production and only the more important specifications are being booked for forward delivery.

Non-ferrous Metals

The downward plunge in metal prices was halted at the beginning of last week, when a recovery took place which sent bear operators hurrying for cover. Cash copper, which at the end of the previous week closed at £222, lost ground heavily on Monday, the unofficial market in the afternoon being £6 down at £216, while three months grounded at £207. Thus, within less than three weeks of the end of the year, the quotation was down by nearly £20, but, as already mentioned, a recovery took place. On balance last week cash eventually gained £2 10s. and three months £2, the backwardation widening to £11 10s. The weakness in lead and zinc proved to be too much for the American market and the prices of both these metals were reduced by ½ cent, the former to 13 cents and the latter to 9½ cents. In London, zinc, after touching £70 for January and £68 15s. for April, recovered to close at a gain of 15s. for the current month, the backwardation widening to 30s. Lead closed 10s. lower for January and £1 down for April, a backwardation of 5s. returning to the market. Earlier in the week this metal touched bottom at £81 15s. for January and £82 5s. April. Tin was steady on the whole, but closed £2 10s. down for both positions. Scrap prices noticeably eased as a result of the setback in new metal values, but are still relatively high in comparison with virgin. Business is not very brisk, for consumers have been badly scared by the reaction that has taken place on the market.

Statistics for the month of December, published by the Copper Institute in New York, show that the month was, on the whole, a busier one than had been expected. In the first place deliveries of refined copper to U.S. consumers, at 112,200 short tons, compared with 100,900 tons in November and this improvement is most satisfactory. Production of crude copper was 88,300 tons, 1,300 tons up on November, while output of refined improved by about 4,000 tons to 123,300 tons. Stocks of refined copper in producers' hands fell to 89,193 tons from the figure of 93,274 tons at the end of November. Outside the U.S.A. production of crude copper was 119,500 tons, compared with 101,200 tons in November, while the output of refined, at 98,500 tons, compared with 79,000 tons a month earlier. Deliveries of refined copper, at 87,000 tons, showed an advance of 7,000 tons.

Official metal prices were as follow:—

COPPER, Standard—*Cash:* January 21, £219 to £219 10s.; January 22, £223 10s. to £224; January 25, £219 to £221; January 26, £223 to £223 10s.; January 27, £225 to £225 10s.

Three Months: January 21, £208 to £209; January 22, £212 to £212 10s.; January 25, £209 to £209 5s.; January 26, £211 10s. to £212; January 27, £213 to £213 10s.

TIN, Standard—*Cash:* January 21, £652 10s. to £655; January 22, £655 to £657 10s.; January 25, £647 10s. to £650; January 26, £645 to £650; January 27, £650 to £652 10s.

Three Months: January 21, £628 to £630; January 22, £630 to £632 10s.; January 25, £625 to £626; January 26, £627 10s. to £628; January 27, £630 to £632 10s.

ZINC—*January:* January 21, £70 10s. to £70 15s.; January 22, £71 15s. to £72; January 25, £71 15s. to £72; January 26, £71 15s. to £72; January 27, £73 to £73 10s.

April: January 21, £69 10s. to £69 15s.; January 22, £70 10s. to £70 15s.; January 25, £70 5s. to £70 10s.; January 26, £70 5s. to £70 10s.; January 27, £71 10s. to £71 15s.

LEAD—*January:* January 21, £82 to £82 5s.; January 22, £83 5s. to £83 10s.; January 25, £83 10s. to £84; January 26, £84 5s. to £84 10s.; January 27, £84 15s. to £85.

April: January 21, £82 5s. to £82 10s.; January 22, £83 5s. to £83 10s.; January 25, £83 10s. to £83 15s.; January 26, £83 10s. to £83 15s.; January 27, £84 to £84 5s.

Scrap Iron and Steel

The Council of Ironfoundry Associations considered at its meeting in December the proposals made by the Ministry of Supply for relaxing their control on the allocation of scrap iron and steel. The Ministry does not intend to remove price control, but they have been urged by the C.F.A. to ease their other restrictions on scrap supplies. The Council considered that the present system of basing allocations on previous consumption was a handicap to those foundries who had an expanding output and that the control necessary was a limitation on stocks. The Council agreed that such a system would give a reasonable degree of flexibility and if a serious scrap shortage arose the Ministry would always introduce more strict licensing arrangements.